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MDPI

Review

Nursing Interventions in the Prevention of Musculoskeletal Injuries in Adolescent Athletes: Integrative Review

Joana Bernardo [1,2,*], Rosa Martins [1], Camila Morgado [1], Henrique do Carmo [1], Luís Aguiar [1], Teresa dos Santos [1], Nélia Carvalho [3] and Ricardo Loureiro [4]

[1] Piaget Institute Viseu, 3515 Viseu, Portugal; rosa.martins@ipiaget.pt (R.M.); 60932@ipiaget.pt (C.M.); 60187@ipiaget.pt (H.d.C.); 60838@ipiaget.pt (L.A.); 60241@ipiaget.pt (T.d.S.)
[2] Polytechnic Institute of Leiria, School of Health Sciences Leiria, 2411 Leiria, Portugal
[3] ULS Viseu Dão-Lafoes, USF-Montemuro, 3600 Viseu, Portugal; mncarvalho2@ulsvdl.min-saude.pt
[4] Center for Innovative Care and Health Technology (ciTechcare), School of Health Sciences, Polytechnic of Leiria, 2411 Leiria, Portugal; ricardo.loureiro@ipleiria.pt
* Correspondence: joana_bernardo@live.com.pt

Abstract

Musculoskeletal injuries are a growing concern among adolescent athletes, with significant physical and psychological consequences. This integrative literature review aimed to analyze the risk factors associated with musculoskeletal injuries in adolescents engaged in sports and to explore the role of nursing interventions in their prevention. A systematic search was conducted across four databases and one gray literature source, including studies published between 2014 and 2024. Three descriptive studies were included, with evidence levels ranging from 3 to 4, according to the Joanna Briggs Institute classification. The main findings highlight that risk factors for musculoskeletal injuries include excessive training loads, inadequate sports technique, lack of professional supervision, improper use of equipment, and failure to recognize early signs of discomfort. Preventive nursing interventions were shown to be effective, particularly those focused on health education, proprioceptive training, and continuous monitoring. Multidisciplinary collaboration between nurses, coaches, and other health professionals emerged as a key strategy in creating safe sporting environments. Despite limitations such as the scarcity of studies on nursing-specific interventions in diverse sports contexts, this review supports the potential of structured, evidence-based nursing actions to reduce musculoskeletal injuries incidence, promote safer sports practices, and enhance adolescent athletes' health outcomes.

Keywords: musculoskeletal injuries; nursing; prevention; adolescents; sport

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1. Introduction

Musculoskeletal injuries (MSKIs) are common among adolescents who engage in sports, with prevalence rates varying but often reported between 30% and 50%, representing one of the main causes of interruption in daily and sporting activities, including school attendance and physical activity [1,2], with a significant negative impact on quality of life [1,3].

These injuries frequently involve the back, knee, and neck. In addition to the physical consequences, these injuries may trigger psychological effects, such as anxiety and demotivation, directly affecting the continuity of sports participation and the overall development of young athletes [1,2,4]. These injuries can be caused or exacerbated by intense physical

activity, constituting a global health and socioeconomic issue, with high prevalence rates reported across several countries [2,3].

According to Vanderlei et al. [5], sports-related MSKIs can be classified into acute injuries and overuse injuries, depending on the injury mechanism and the manifestation of symptoms. Acute injuries occur suddenly and are often associated with traumatic events during training or competition. Overuse injuries, on the other hand, develop gradually due to repetitive strain over time. Early diagnosis of these injuries is essential to minimize complications and preserve adolescents' quality of life. For example, recent biomechanical analyses further highlight that specific movement patterns, such as landing techniques in volleyball spike shots, can influence the kinetic and kinematic load on the musculoskeletal system, thereby increasing the risk of injury [6]. This type of evidence illustrates how sport-specific mechanisms should be considered when designing prevention strategies for adolescent athletes.

Sports participation, particularly in contact sports, is associated with a higher likelihood of MSKIs [7]. Symptoms generally include pain, often localized but which may radiate to other areas of the body; numbness in the affected region; and muscle fatigue or discomfort. Musculoskeletal symptomatology is complex, involving both physiological and psychological aspects, making diagnosis and treatment more challenging. Therefore, early diagnosis is crucial to preserve quality of life and prevent worsening of the injury [8].

Nurses' engagement in the field of sports medicine, although less frequent than in other health domains, is centered mainly on health education, monitoring, and early detection of risk factors that may predispose athletes to injuries [7,9,10]. Their role often involves guiding athletes, parents, and coaches on safe training practices, recognizing early signs of musculoskeletal strain, and promoting lifestyle strategies that reduce injury risk. In many sports settings, nurses also contribute within multidisciplinary teams, collaborating with physiotherapists, physicians, and coaches to implement evidence-based injury prevention programs. While this practice area remains a niche, these interventions highlight the potential of nursing to contribute meaningfully to sports injury prevention, especially in adolescent populations [10,11].

The increasing participation of adolescents in sports is directly linked to a rise in MSKIs, especially in contact sports [7]. Identifying the risk factors associated with MSKIs is essential for implementing appropriate preventive measures targeting young athletes, promoting not only their physical health but also their psychological and social well-being. These risk factors include excessive training loads, poor sports techniques, inappropriate equipment, lack of professional supervision, and insufficient warm-up routines [9].

International organizations have also emphasized the importance of structured prevention strategies in youth sports. The World Health Organization [12] highlights injury prevention as a key component of promoting safe participation in physical activity for children and adolescents, while the American Academy of Pediatrics (AAP) [13] recommends evidence-based warm-up, training load monitoring, and early health supervision to reduce sports-related injuries in youth.

Nursing, as a profession focused on health promotion, plays a fundamental role in the prevention of MSKIs, particularly among adolescents, who are a vulnerable group due to their physical development and the intensity of sports practice [9]. Through educational interventions, nurses can guide adolescents, parents, and coaches on adopting safe practices and recognizing early signs of injury, such as persistent pain and muscle discomfort. Prevention is thus a key tool to minimize the impact of injuries and avoid serious complications [3].

Although existing evidence highlights the importance of nursing in preventing MSKIs in adolescents, there is still a lack of studies identifying the risk factors associated with

MSKIs in adolescent athletes and the specific impact of nursing interventions. Most of the literature has focused on general injury prevention strategies or the role of other health professionals, such as physiotherapists [11,14] leaving a gap in knowledge regarding the identification of risk factors and the direct contribution of nursing interventions to their prevention. This gap justifies conducting an integrative literature review (ILR) on the topic, aiming to gather and analyze the existing evidence.

Nursing practice should therefore be grounded in scientific evidence to ensure informed and effective decision-making in clinical settings [15]. The choice of an ILR as the methodology for this study allows for the analysis and synthesis of relevant research data, contributing to the advancement of nursing practice and strengthening the evidence base for healthcare delivery. This process facilitates the identification of risk factors and the implementation of more effective and targeted interventions for MSKI prevention.

The general aim of this study is to analyze the risk factors associated with MSKIs in adolescent athletes and explore the role of nurses in their prevention. To achieve this aim, the following specific objectives were defined: (i) To identify the main physical, behavioral, and environmental risk factors associated with the development of MSKIs; (ii) To explore preventive nursing interventions described in the literature; and (iii) To identify gaps in the literature and suggest recommendations for future research. It is hypothesized that the implementation of meticulously formulated nursing interventions can result in a substantial reduction in the prevalence of musculoskeletal injuries among adolescent athletes.

2. Materials and Methods

2.1. Type of Study

This study is based on an ILR, using scientific studies published in various databases and sources of gray literature. The evidence will be analyzed and synthesized in order to provide a clear and comprehensive interpretation of the data [16].

The ILR is a secondary research methodology that integrates studies with different methodological approaches, allowing for a comprehensive synthesis of the evidence. This type of review is particularly relevant in the field of nursing, as it contributes to clinical practice by promoting critical analysis of evidence-based interventions [16].

The ILR enables the aggregation of a large amount of information, making it a powerful tool for the advancement of evidence-based practice. It is characterized by being reproducible, unbiased, transparent, comprehensive, and replicable. By reducing bias and employing explicit methods in the search for relevant studies, it contributes to a more rigorous evaluation of the existing literature [16].

An ILR must follow a set of fundamental principles to ensure its quality and rigor. These include being exhaustive, encompassing all relevant literature; following a rigorous methodology, documenting each step of the review process—from the formulation of the research question to data analysis; adopting a sensitive search strategy that covers various databases and resources to locate pertinent studies; and involving, whenever possible, more than one researcher in article selection and data extraction to ensure objectivity and minimize bias [16,17].

An integrative literature review (ILR) was selected as the methodological approach for this study, as it allows for the inclusion of empirical and theoretical publications with different methodological designs, thereby providing a comprehensive understanding of the phenomenon under analysis [17]. Unlike systematic reviews of effectiveness, which focus on narrowly defined clinical questions and require a homogeneous set of studies for meta-analysis, or scoping reviews, which aim primarily to map the breadth of evidence without critically appraising it, the ILR is particularly suitable when the objective is both to synthesize evidence and to generate new theoretical insights [16,17]. Given the exploratory

nature of the topic—nursing interventions in the prevention of musculoskeletal injuries in adolescent athletes—and the scarcity of high-level studies in this area, the ILR method was deemed most appropriate to capture and critically analyze the available evidence.

This study followed the ILR steps with the aim of identifying the risk factors associated with MSKIs in adolescent athletes and exploring the role of nurses in their prevention. The ILR enabled a comprehensive synthesis of the available evidence on the topic, systematically organizing the findings. The research and analysis process was divided into the following stages:

- Identification of the topic and formulation of the research question: At this stage, the study problem was defined, the research question was formulated, and the search strategy was established, including the definition of descriptors, databases, and resources to be used.
- Definition of inclusion and exclusion criteria: Criteria were established for the selection of studies, based on which the searches were conducted in the selected databases and resources.
- Identification of pre-selected and selected studies: The screening of titles and abstracts was performed independently and in duplicate by two members of the review team (CM, HC, LA and TS). Discrepancies were discussed and resolved by consensus, with the involvement of a third (RM or JB). Full-text articles that met the inclusion criteria were subsequently reviewed in collaboration by the entire review team, ensuring methodological consistency and reliability of the selection process.
- Categorization of selected studies: A data extraction and synthesis table was developed at this stage, to analyze the information extracted from the selected studies.
- Analysis and interpretation of results: Data analysis was followed by discussion of the findings, enabling interpretation and understanding of the implications of the evidence.
- Presentation of the review/knowledge synthesis: The final stage consisted of the development of this detailed document, which describes the review conducted and proposes recommendations for future research.

2.2. Research Question

The first step in conducting an ILR is formulating a research question. The focus of the question is essential: if it is too narrow, identifying relevant studies becomes more difficult and the generalization may be limited; conversely, if the question is too broad, drawing applicable conclusions for a specific population becomes challenging [18].

To clarify the aim of this research, the PICO mnemonic was used as an investigative framework. This tool assists in the organization and identification of the problem and, by considering four key elements—Population (P), Intervention (I), Comparison (C), and Outcomes (O)—the following research question was formulated: "What are the risk factors associated with musculoskeletal injuries in adolescent athletes, and how can nurses contribute to the prevention of these injuries?"

Accordingly, the aim is to establish a line of inquiry focused on young individuals engaged in sports activities, aged between 7 and 18 years (Population), analyzing the risk factors associated with the development of MSKIs to support preventive actions (Intervention), without an explicit comparison group (Comparison), and focusing on the nurse's role and the implementation of MSKI prevention strategies (Outcomes), as presented in Table 1.

Table 1. PICO Mnemonic.

PICO Component	Description
Population (P)	Adolescent athletes aged 7 to 18 years.
Intervention (I)	Identification of risk factors and preventive interventions related to MSKIs.
Comparison (C)	No explicit comparison group.
Outcomes (O)	Reduction in MSKI incidence, improvement of physical performance parameters (e.g., balance, postural stability), and increased awareness of injury risk factors.

For the purposes of this review, nursing interventions were defined as actions delivered or potentially deliverable by nurses, grounded in the nursing scope of practice and directed towards health promotion, risk reduction, or early identification of musculoskeletal injuries. These interventions include health education tailored to athletes, parents, and coaches; monitoring of risk factors (e.g., training load, early musculoskeletal symptoms); and counseling to promote adherence to safe sports practices. They differ from physiotherapy interventions, which primarily focus on rehabilitation and targeted physical therapy after injury, and from coaching strategies, which emphasize sport-specific technical and tactical performance. Unlike general health education, nursing interventions are characterized by their holistic, person-centered approach, integrating physical, psychological, and social dimensions of adolescent health within a multidisciplinary framework [10,11,19].

2.3. Inclusion and Exclusion Criteria

In conducting an ILR, the clear and rigorous definition of inclusion and exclusion criteria is essential to ensure the quality and relevance of the selected studies. These criteria must be explicitly and objectively defined in order to avoid judgment errors that may compromise the validity of the review [20].

The inclusion and exclusion criteria were established based on the research question and aligned with the components of the PICO mnemonic, thus ensuring the relevance of the selected studies. According to Apóstolo [21], inclusion criteria should be clearly identifiable and directly related to the research question. These criteria must be detailed and allow for an unambiguous distinction between studies that are eligible and those that are not relevant to the review.

To ensure the relevance of the studies for analyzing risk factors associated with MSKIs in adolescent athletes, as well as nursing interventions aimed at their prevention, the following inclusion criteria were defined:

- Studies must include adolescents aged between 7 and 18 years who actively participate in sports;
- Studies must identify risk factors associated with the development of MSKIs, as well as explore the role of nurses in implementing MSKI prevention interventions.

In addition, the following exclusion criteria were applied:

- Systematic reviews and meta-analyses, as the study aimed to analyze primary research providing original data;
- Publications without free full-text access or outside the defined time frame, to ensure completeness and relevance of the data analyzed.

2.4. Search Strategy

The strategies used in the search process must be described clearly and objectively, ensuring transparency and reproducibility [18]. At this stage, a systematic search was conducted for publications related to the proposed topic, using electronic databases with free access, selected for their relevance and methodological quality, as well as sources of gray literature. The search strategy was designed to include a variety of information sources and cover a broad range of studies relevant to the subject under investigation [21].

According to Donato & Donato [18], the descriptors were selected based on the components of the PICO mnemonic (Population, Intervention, Comparison, Outcomes), which allowed for a clear organization of the research question and the elements to be investigated. To operationalize the search, Boolean operators were used to refine results and ensure the relevance of the retrieved articles:

- AND (restrictive combination): to include articles that contain all specified search terms;
- OR (additive combination): to include articles containing any of the specified terms, thus broadening the scope of the search.

In line with Aromataris and Munn [20], a comprehensive search should include multiple databases, gray literature sources, and relevant handbooks to ensure that different types of evidence are considered. Therefore, three freely accessible electronic databases with broad and relevant coverage for the field under study were selected, along with one gray literature resource, as follows: MEDLINE (via PubMed), SciELO, LILACS (via BVS) and Google Scholar (limited to the first 10 pages of results).

Keywords and descriptors were validated using MeSH (Medical Subject Headings) and combined using the Boolean operators AND and OR, as demonstrated in Table 2. The descriptors were selected based on the PICO components, ensuring comprehensive coverage of all aspects of the research question.

Table 2. Search Strategies Applied in Scientific Databases.

Search Strategy	Gray Literature Resource/Scientific Database	Number of Records Retrieved
Youth sports AND Nursing AND Sports injuries	Google Scholar	100
Youth sports AND Sports injuries	SciELO	6
(“Youth sports” [MeSH] OR Athletes OR Sports People) AND (“Nursing” [MeSH] OR Nursing Interventions) AND (“Sports injuries” OR Musculoskeletal injuries)	MEDLINE (via PubMed)	39
Youth sports AND Sports injuries	LILACS (via BVS)	10
Youth sports AND Sports injuries	PEDRo	17

The search strategies presented in Table 2 were adapted to the indexing and thesaurus system of each database, ensuring the inclusion of both controlled vocabulary terms (such as MeSH) and free-text keywords. Boolean operators were used to refine the search results, and all searches were conducted in Portuguese, English, and Spanish, whenever possible, to broaden the scope of the evidence retrieved.

To ensure the quality and relevance of the selected studies, specific filters were applied, including:

- Publication Period: Articles published between 2014 and 2024, ensuring the inclusion of recent data and up-to-date evidence on the topic;
- Languages: Articles in Portuguese, English, and Spanish, to encompass a wide range of sources and regional perspectives;
- Availability: Exclusion of articles with restricted access or without full-text availability, ensuring that all analyzed studies were accessible;
- Type of Study: Experimental, quasi-experimental, descriptive, and cross-sectional studies were selected, as these are most suitable for identifying risk factors and nursing interventions for prevention.

2.5. Data Extraction and Analysis

The data extracted from the selected studies were organized and analyzed systematically, according to the following steps:

Step 1: Data Extraction and Organization: Relevant information from each study was extracted using a structured form (Table 3), which included the following fields: author(s), year and country of publication, title, study objective, study design, participants, intervention and data collection instruments, results, and level of evidence [20]. The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools [22]. Each study was appraised independently by two reviewers, and discrepancies were resolved by consensus. A summary of the quality assessment criteria and results is presented in Supplementary Material. The extracted information was then organized in synthesis tables to facilitate comparison across studies and to identify patterns or discrepancies in the findings.

Table 3. Data Extraction and Organization Table.

Field	Description
Author(s)	Name(s) of the study authors
Year, Country	Year of publication and country where the study was conducted
Title	Title of the article
Study Objective	Description of the study's objective
Study Design	Experimental, quasi-experimental, descriptive, or cross-sectional studies
Participants	Description of the study sample size
Intervention	Description of the intervention and data collection instruments
Results	Summary of the main findings
Level of Evidence	Classification according to JBI (2020)

Step 2: Data Analysis and Synthesis: The extracted data were analyzed and integrated to provide a comprehensive understanding of the risk factors associated with MSKIs in adolescent athletes, as well as the nursing interventions aimed at their prevention. This analysis and synthesis enabled the identification of the best available evidence, existing gaps, and implications for clinical practice, thereby guiding future interventions and research in the field.

Step 3: Presentation of Results: The results were organized and presented in a clear and concise manner using a table and descriptive narratives. This presentation supports the understanding of the available evidence and contributes to informed decision-making in nursing practice focused on the prevention of MSKIs in adolescent athletes.

The review process was reported in accordance with the PRISMA 2020 checklist [23].

3. Results

The search was conducted on November 19, 2024. A total of 172 records were retrieved: MEDLINE (n = 39), SciELO (n = 6), LILACS (n = 10), PEDRo (n = 17) and Google Scholar (n = 100, limited to the first 100 results). Figure 1 presents the PRISMA flowchart, illustrating the steps taken for the inclusion of articles.

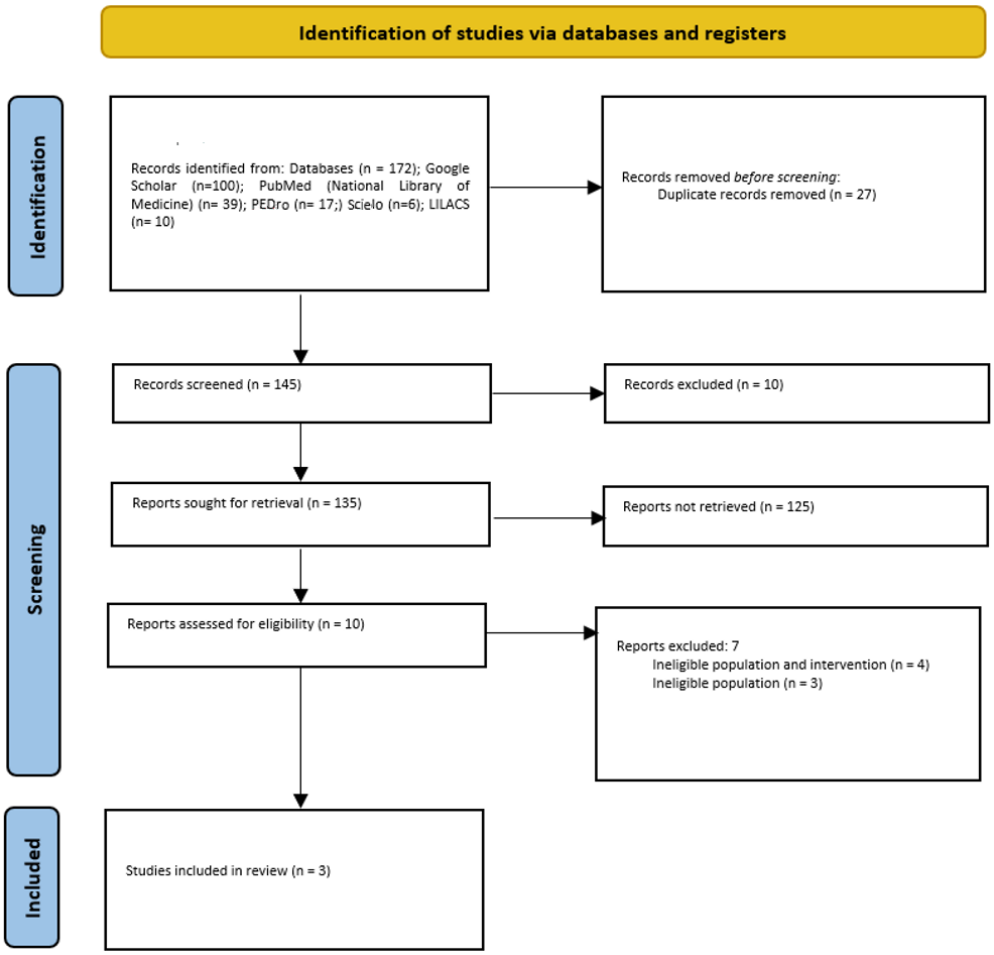

Figure 1. Search results, study selection and inclusion process according the PRISMA Flow Diagram [23].

Characterization of Included Studies

Three primary studies were included in this integrative literature review, all published between 2014 and 2024. The studies were descriptive in nature, with varying methodological designs—correlational, observational, and quantitative—falling under Level 3 and Level 4 evidence, according to the JBI classification [20].

To ensure methodological transparency, the eligibility and exclusion criteria applied at each stage of the selection process are summarized in Table 4. This table provides a clear overview of how studies were progressively filtered, from title and abstract screening to full-text assessment and final inclusion, thereby clarifying the rationale behind the number of records excluded at each step.

Table 4. Eligibility and exclusion criteria across selection phases.

Selection Phase	Inclusion Criteria Applied	Exclusion Criteria Applied	Records Excluded (n)
Title/abstract screening	Age 7–18; athletes; focus on MSKIs and nursing	Non-sporting populations; other professionals; outside time frame	10
Full-text assessment	Nursing intervention described; primary research	Reviews, theses without full text, non-English/Portuguese/Spanish	132
Final inclusion	Studies meeting all criteria	–	3

The main characteristics of the included studies are presented in Table 5, which incorporates details: Author(s), Year, Country, Study Design, Level of Evidence, Study Objective, Participants (n, average age, sex) and Main Findings (contemplate Nursing intervention (type, duration, provider)).

Table 5. Characteristics of the included studies.

Author(s), Year,	Study Design	Level of Evidence	Study Objective	Participants (n, Average Age, Sex)	Main Findings (Contemplate Nursing Intervention (Type, Duration, Provider))
Study 1—Liu et al. (2024) [24]	Descriptive and correlational	Level 3	To identify the prevalence of sports-related musculoskeletal injuries (MSI) in young athletes and to analyze the factors influencing such injuries.	108 young athletes	64.8% of young athletes reported having experienced at least one MSI during their sports practice; 43.5% of young athletes sustained an MSI in the 12 months prior to the study.
Study 2—Martins et al. (2021) [25]	Descriptive quantitative	Level 4	To explore the etiology, diagnosis, treatment, and prevention of sports-related knee MSIs in children.	108 children (66 male, 42 female)	There was a significant increase in the number of children hospitalized with sports-related knee MSIs between 2019 and 2021.
Study 3—Antunes (2019) [15]	Descriptive observational	Level 4	To prevent MSIs in young athletes through proprioceptive training; to integrate specific warm-up programs that promote balance and neuromuscular control, such as FIFA 11+ Kids; and to demonstrate the role of the specialist nurse in injury prevention in sports settings.	12-year-old youths with spinal and lower limb injuries	Implementation of the FIFA 11+ Kids program in regular training sessions showed potential for reducing MSI incidence. Evidence of improvement in both static and dynamic balance was observed, with a positive impact on postural stability. Integration of balance exercises in warm-ups proved effective in reducing severe injuries.

Three descriptive studies were identified, each focusing on musculoskeletal injuries (MSIs) in pediatric and adolescent populations involved in sports activities. These studies employed different methodological approaches and aimed to explore various aspects related to the occurrence and prevention of MSIs in young athletes.

From the three descriptive studies included [15,24,25], four main themes emerged: (i) risk factors associated with musculoskeletal injuries (MSKIs), (ii) preventive intervention strategies, (iii) the role of nurses in prevention, and (iv) evidence gaps.

1. Risk factors for MSKIs

Across the studies, the most frequently reported risk factors were excessive training load, inadequate sport techniques, insufficient warm-up routines, inappropriate equipment, and lack of professional supervision [24,25]. Epidemiological data also revealed that MSKIs were more prevalent in lower limbs (particularly the knee) and spine, with age, gender, and type of sport influencing injury occurrence [24,25]. These findings highlight the multifactorial nature of MSKIs in adolescent athletes, where both intrinsic (age, sex, history of injury) and extrinsic (training conditions, equipment, supervision) factors play a role.

2. Preventive interventions

One of the studies tested proprioceptive training programs, such as FIFA 11+ Kids, focusing on warm-up and neuromuscular control, which demonstrated improvements in balance and postural stability [15]. Other interventions emphasized health education strategies, monitoring of training loads, and early detection of risk factors [24,25]. Although promising, these interventions were mostly exploratory and limited in scope, requiring further testing through higher-level research designs.

3. Role of nurses in prevention

The nurse's involvement was primarily centered on educational and preventive protocols. Their contribution included providing guidance on training safety, equipment use, recognition of early signs of strain, and continuous support to athletes and [15]. Nurses were also described as key actors in promoting a multidisciplinary approach by collaborating with physiotherapists, physicians, and coaches [15,24]. However, the studies rarely positioned nurses as the main providers of interventions, which limits the strength of inferences regarding their unique role.

4. Evidence gaps

The included studies were all descriptive (JBI levels 3–4), with small sample sizes and limited methodological robustness [15,24,25]. None of the studies used randomized controlled designs, and the direct impact of nursing-led interventions remains underexplored. Furthermore, there is a paucity of research comparing outcomes across different sports contexts (school, recreational, competitive), which restricts the generalizability of findings.

To complement the synthesis of findings, Figure 2 provides a conceptual representation of the relationship between musculoskeletal injury (MSKI) risk factors and nursing interventions in adolescent athletes. The figure displays, on the left, the main risk factors identified in the literature, namely excessive training load, inadequate sports techniques, inappropriate equipment, insufficient warm-up, and lack of professional supervision. On the right, the corresponding nursing interventions are presented, including load management and recovery education, promotion of safe techniques, guidance on equipment use, implementation of structured warm-up and stretching programs, and continuous monitoring and support. This visual framework illustrates how nursing can act preventively within multidisciplinary teams, promoting safer sports practices and contributing to the reduction in injury risk among adolescents.

Each of these studies contributes to the growing body of descriptive research focusing on the characterization and prevention of MSIs in youth sport contexts. Through various methodological approaches and distinct populations, they provide important insights into the dynamics of injury occurrence, highlighting different aspects of sports-related health challenges in children and adolescents.

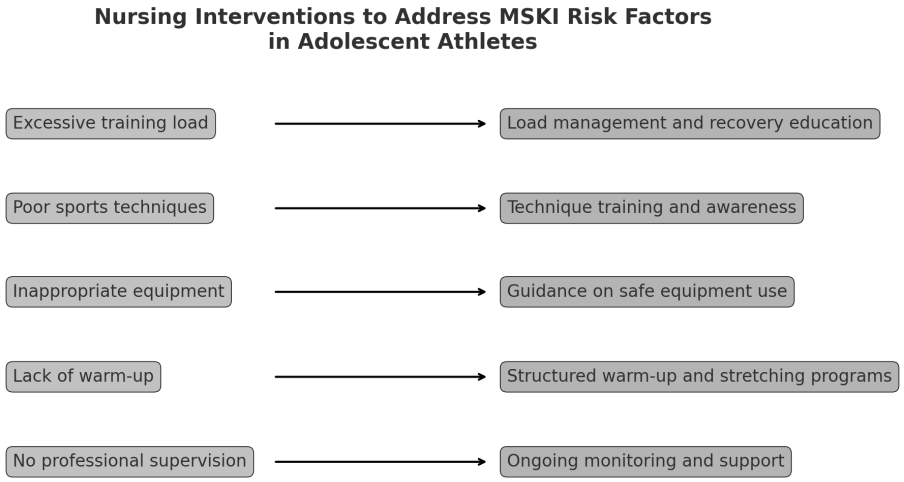

Figure 2. Conceptual representation of the relationship between musculoskeletal injury (MSKI) risk factors and nursing interventions in adolescent athletes.

4. Discussion

The risk factors associated with musculoskeletal injuries (MSIs) in adolescent athletes are diverse and include physical, behavioral, and environmental elements. Identifying and understanding these factors is essential for the development of effective preventive interventions, which is one of the primary objectives of this integrative literature review. Studies have indicated that physical overload, inadequate technique, and lack of professional supervision are among the main risk factors for the development of MSIs [26,27]. Additionally, variables such as inappropriate BMI and excessive repetition of intensive movements are frequently linked to these injuries, as evidenced by Martins et al. [25]. In the three studies analyzed, the results are consistent with existing literature. In Martins et al. [25] highlights the absence of technical supervision and the use of inappropriate equipment as primary risk factors. Sugimoto et al. [27] complement this view by emphasizing that the lack of appropriate technical support is a common issue among young athletes, often resulting in mechanical overload and improper equipment use, especially in disciplines that involve repeated execution of specific movements. Furthermore Sugimoto et al. [27] stress that in contexts where coaches or supervisors lack sufficient training to correct technique or ensure correct equipment usage, injury rates increase substantially. This lack of qualified supervision not only contributes to the repetition of biomechanically incorrect movements but also to the continued use of inappropriate materials which, over time, intensify the risk of MSIs.

Liu at al. [24], reinforces that high-intensity repetitive training may lead to joint overload, especially in adolescents undergoing growth spurts. This period is characterized by biomechanical changes that increase vulnerability to injuries, as noted by Ding et al. [28], who also emphasize the importance of evidence-based preventive programs such as FIFA 11+ in reducing lower limb injuries. This is further supported by Antunes [15] which underlines the relevance of proprioceptive training in reducing risk factors. Strategies such as muscle strengthening and balance training are identified as key components to mitigate the risk of injuries caused by repetitive intensive movements. Behavioral factors, such as ignoring early signs of discomfort or pain, also play a critical role. Studies such as Campbell et al. [29] show that athletes who neglect such signs are more likely to develop chronic and more severe injuries. Therefore, education on the importance of early recognition and management of such symptoms is essential, with the nurse's intervention playing a pivotal role in this process.

Nurses play a central role in the prevention of MSIs, particularly through educational programs and health monitoring. As highlighted by Antunes [15], continued education directed at young athletes, coaches, and parents is essential to promote safe practices. This preventive role includes interventions such as the development of personalized muscle-strengthening programs and the use of appropriate stretching techniques. Sugimoto et al. [27] reinforce this view by noting that ongoing support from qualified professionals can mitigate risks associated with improper equipment use and incorrect execution of sports techniques, both of which are linked to a higher incidence of MSIs. Nurses' educational interventions are fundamental to raise awareness among young athletes and their families about the importance of safe practices, such as the diversification of physical activities and the adoption of adequate training loads. Sugimoto et al. [27] also point out that educational approaches should address the harmful effects of excessive repetitive training and the importance of recognizing warning signs, such as persistent pain, which may evolve into chronic injuries. Campbell et al. [29] add that educational interventions can reduce the culture of "training through pain," which is often deeply ingrained in sports environments.

Proprioceptive training, in particular, has proven to be one of the most effective strategies for the prevention of MSIs. According to Antunes [15] in study 3, this type of training improves balance, motor coordination, and postural control, significantly reducing the risk of injuries. Programs such as FIFA 11+ Kids, widely used in youth football, are examples of evidence-based interventions that have shown a positive impact in reducing common injuries such as ankle sprains and knee injuries [30]. Additionally, the continuous monitoring conducted by nurses allows for the early detection of warning signs such as persistent pain or muscle discomfort. Ding et al. [28] point out that early interventions not only prevent the progression to more severe injuries but also significantly improve prognosis and reduce rehabilitation time. In this sense, the role of the nurse goes beyond occasional prevention, encompassing educational activities, evidence-based interventions, and ongoing monitoring. These professionals are essential in fostering and implementing a safe sporting culture that prioritizes the health and well-being of young athletes, minimizing the risks of MSIs while maximizing the benefits of sports participation.

Collaboration between nurses, coaches, and other health professionals is essential for the prevention of MSIs, as it enables a more comprehensive and personalized approach to the needs of athletes. Teamwork is crucial to ensuring that interventions are evidence-based, consistent, and effective. Martins et al. [25], in study 1, reinforces that integrating efforts leads to the creation of safer training plans adapted to the individual conditions of each athlete. This personalized approach is particularly relevant in sports contexts, where factors such as age, physical development, injury history, and training load must be carefully monitored. Sugimoto et al. [27] further argue that poor communication among support staff is a risk factor for repeated technical errors and for the absence of timely preventive interventions. Antunes [15], in study 3, adds that a multidisciplinary approach facilitates communication between teams, ensuring that athletes receive consistent, evidence-based guidance. Interdisciplinary collaboration allows nurses, as health specialists, to participate in the assessment of physical condition and in the early identification of risk signs, as described in study 2 by Liu et al. [24]. This includes detecting persistent pain, incorrect movement patterns, or signs of physical overload [28].

A multidisciplinary approach not only reduces injury incidence but also promotes overall athlete well-being [30]. By working together, nurses and coaches ensure that athletes understand the importance of safe practices, develop healthy habits, and recognize early warning signs, as mentioned by Antunes [15] in study 3. Sugimoto et al. [27] also stress that this collaboration contributes to a more health-conscious sporting culture, where the focus is on the long-term health and athletic longevity of young athletes. This teamwork ensures

a holistic and individualized approach that addresses both the physical and behavioral-social factors influencing injury risk. Moreover, it fosters integrated communication and the implementation of evidence-based strategies, resulting in significant benefits for both athlete health and performance.

When revisiting the PICO framework defined in this review, the studies included allow us to address the research question partially. The population (adolescent athletes aged 7–18) and the interventions (risk factor identification and preventive strategies) were consistently present in the evidence analyzed. However, the outcomes—particularly the direct evaluation of nursing contributions to MSKI prevention—were only indirectly addressed, with improvements noted in injury incidence reduction, balance, and awareness of risk factors. This highlights both the relevance of the findings and the gap in nursing-specific evidence.

Thus, although the studies included in this review demonstrate the importance of nursing interventions in the prevention of MSIs, there remain significant research gaps. There is a lack of studies evaluating the impact of preventive interventions across different sports modalities. Antunes [15], in study 3, suggests that future research should explore tailored strategies for specific groups of athletes. Nurses play an indispensable role in both the prevention and rehabilitation of MSIs, with responsibilities ranging from health education to continuous monitoring of young athletes' health. The implementation of customized programs, such as proprioceptive training, and collaboration among healthcare professionals are essential strategies to reduce injury incidence and enhance athletes' well-being. Further studies are necessary to consolidate evidence-based practice and promote advances in MSI prevention in sports contexts.

The critical appraisal conducted using the JBI checklists revealed methodological limitations across all three included studies. The two cross-sectional studies [24,25] clearly defined inclusion criteria, described the population and setting in detail, and applied appropriate statistical analysis; however, they lacked clarity regarding strategies to manage confounding factors and the validity of outcome measurement, which may compromise internal validity. The cohort study [15] identified relevant confounders and used appropriate statistical analysis, yet it presented limitations in group comparability at baseline, the measurement of exposures, and the description of follow-up procedures.

During the development of this research, several barriers and limitations were encountered. One of the main challenges was the scarcity of scientific articles directly related to the topic. The search for studies that met the inclusion criteria proved difficult, which in some instances limited the development of the work. This limitation reinforces the need for greater scientific production in the field of nursing and may serve as a stimulus for future investigations. Another limitation identified was the difficulty in articulating nursing interventions with those of other healthcare professionals, such as physiotherapists and occupational therapists. This coordination was not always feasible due to the irregular presence of such professionals in services and the lack of structured multidisciplinary collaboration. This limitation reflects a common challenge in nursing practice, which may compromise the effectiveness of interventions. These challenges underscore the need for further studies on nursing interventions for MSI prevention in adolescent athletes, greater interdisciplinary coordination among healthcare professionals, and more effective strategies for resource management.

The practical implementation of injury prevention programs in adolescent sports is frequently hindered by contextual barriers such as limited resources, lack of trained staff, and insufficient adherence to recommended practices [31]. Systematic reviews emphasize that, despite the proven effectiveness of structured interventions, their impact is often constrained by inconsistent application across different sports settings, including schools, community clubs, and competitive environments [32,33]. In particular, limited collabo-

ration between health professionals and sports organizations remains a critical obstacle to the sustainability of preventive measures [34]. Nurses, with their expertise in health promotion and risk factor identification, can address these gaps by strengthening primary prevention strategies, offering continuous monitoring, and enhancing communication between athletes, parents, and coaches. Their integration into multidisciplinary teams thus represents a distinctive contribution to the broader adoption and effectiveness of prevention programs [10,11].

This review is limited by the small number of included studies (n = 3), all of which presented low levels of evidence (JBI levels 3–4) and restricted diversity in the interventions analyzed. These factors reduce the strength of the inferences that can be drawn and highlight the need for caution when interpreting the findings. As such, the results should not be fully generalized, but rather considered as preliminary insights into the role of nursing in the prevention of MSKIs among adolescent athletes.

This work represents a fundamental step in the completion of academic training, which adds an additional layer of rigor and responsibility. Every effort was made to overcome the challenges encountered, with dedication and commitment. This process proved to be an enriching journey, enabling the acquisition of highly relevant knowledge and skills for future professional practice. It is believed that the limitations and obstacles faced are part of the learning process and should be viewed as opportunities for academic and professional growth.

Future research should prioritize the development of robust study designs to consolidate the evidence base for nursing-led interventions in musculoskeletal injury prevention among adolescent athletes. Randomized controlled trials (RCTs) are needed to test the effectiveness of structured nursing programs (e.g., warm-up protocols, load monitoring, health education sessions) across diverse sports. Complementary qualitative studies should also be conducted to explore the perceptions of athletes, parents, and coaches regarding the feasibility, acceptability, and barriers to the implementation of these interventions. Furthermore, sport-specific trials focusing on high-risk disciplines such as football, volleyball, or gymnastics could help to tailor nursing interventions to the demands of each modality. Multicenter and longitudinal studies would additionally strengthen external validity and provide insights into the sustainability of preventive practices over time.

5. Conclusions

The present ILR aimed to analyze the risk factors associated with MSI in adolescent athletes and to explore the role of nurses in their prevention, by reviewing studies and theses published between 2014 and 2024. The analysis of the studies included in this review provided relevant insights into the crucial role of nursing in preventing MSI among young athletes.

Overall, the interventions analyzed indicate that health education plays a key role in raising awareness among parents, athletes, and coaches regarding the importance of safe sports practices and the proper use of equipment. These findings reinforce the relevance of multidisciplinary approaches that integrate nursing professionals in the implementation of educational interventions and specific training practices, with the aim of promoting health and reducing the incidence of injuries in youth sports.

Despite some limitations, this study contributes to highlighting the significant role of nurses in health promotion and MSI prevention, supporting progress in the development of evidence-based interventions. It is recommended that future studies explore the effectiveness of different nursing-led interventions across various sports and settings, in order to strengthen the body of evidence supporting the role of nursing in this specific field.

The findings of this review should be interpreted with caution. Although the evidence suggests potential contributions of nursing interventions to the prevention of MSKIs in adolescent athletes, the scarcity and low quality of the available studies underline the need for further high-quality research before definitive conclusions can be drawn.

When nursing interventions are implemented in a structured manner, they have the potential to significantly reduce the incidence of MSIs, improve the quality of life of young athletes, and promote safer and more sustainable sports practices. The evidence synthesized indicates that preventive interventions can contribute to reducing injury incidence, improving balance and postural control, and increasing awareness of musculoskeletal risk factors among adolescent athletes. Nevertheless, the lack of studies directly involving nurses as intervention providers reinforces the need for further research to strengthen the evidence base for nursing practice in this field.

In implications terms, this review highlights the importance of incorporating nurses into multidisciplinary sports medicine teams, particularly in school and community settings, where they can contribute to education, early screening, and injury surveillance. At the policy level, sports and health authorities should consider the inclusion of nursing interventions in adolescent injury prevention programs, promoting sustainable and cost-effective strategies. Future research should prioritize clinical trials testing structured nursing-led interventions, comparative studies with other health professionals such as physiotherapists, and investigations across diverse sports contexts (school, recreational, and competitive) to consolidate evidence and inform both clinical practice and public health guidelines.

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