



The Role of Physiotherapy Methods in the Management and Prevention of Upper Extremity Injuries in Professional Pianists: A Scoping Review

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Abstract

Background. Professional musicians are at significant risk of upper limb injuries, as prolonged practice and intensive playing increase the likelihood of musculoskeletal disorders and overuse injuries, particularly in pianists. Altenmüller and Kopiez (2010) demonstrated that chronic upper extremity injuries and pain syndromes resulting from intensive piano practice can be successfully treated using multimodal therapy, including physiotherapy, psychotherapy, and modifications of playing technique, enabling musicians to fully restore performance skills. However, there is a notable lack of scientific literature and knowledge regarding physiotherapy interventions for professional pianists, particularly concerning injury management and preventive strategies.

Aim. To obtain and compile current evidence on physiotherapy processes and methods used for the management and prevention of upper extremity injuries in professional pianists, and to explore the scope of available approaches in this field.

Methods. A scoping review was conducted following the Joanna Briggs Institute (JBI) methodology. A systematic search was performed in PubMed, Web of Science, EBSCOhost, MEDLINE Ultimate, and ProQuest. Additional sources included books and relevant publications. The PCC framework was applied: Participants – pianists with piano-related upper extremity injuries; Concept – physiotherapy plans and methods for injury management and prevention; Context – clinical, educational, and home settings. Publications in English from the past 50 years were included.

Results. A scoping review on the management and prevention of upper extremity injuries in pianists included English-language publications from the past 50 years, along with additional relevant sources. Of 54 identified studies, 45 met the inclusion criteria. The findings indicate that primary risk factors are biomechanical overload, improper technique, and poor ergonomic habits.

Conclusions. Physiotherapy plays a significant role in both the management and prevention of upper extremity injuries in pianists. Injury management and prevention involve adhering to ergonomic principles, physiotherapy, and learning proper technique from an early age. Collaboration between educators and healthcare professionals is essential for the long-term health and career sustainability of pianists.

Keywords: Physiotherapy; injury prevention; musculoskeletal disorders; biomechanical overload injuries; isometric strength exercises



1. INTRODUCTION

Professional musicians are at risk of upper limb injuries, as prolonged practice sessions increase the likelihood of such conditions, with pianists representing one of the groups with a particularly high incidence of musculoskeletal disorders and overuse injuries affecting the upper extremities. Historically, the most famous pianist and composer to suffer from a hand injury was Robert Schumann (Altenmüller & Jabusch, 2010; Altenmüller & Kopiez, 2010; Wasielewski & Alger, 1871; Winspur & Parry, 1988). Injuries have a significant impact on performing musicians, as they cause muscle and tendon pain, weakness, stiffness, and coordination deficits directly affecting pianists' ability to perform, interpret, and maintain a high level of technical execution (Berezutskyi & Berezutska, 2020; Fry et al., 1998).

The results of a systematic review revealed that piano-related musculoskeletal disorders, particularly in the upper extremities, affect up to 89% of musicians over their lifetime (Betzl et al., 2020). The forearm and hand are most commonly affected, with pain, muscle weakness, stiffness, and impaired motor control reported as the predominant symptoms. These findings highlight the urgent need for effective preventive and therapeutic strategies, as well as the necessity for evidence supporting the efficacy of such approaches. Altenmüller and Kopiez (2010) and Guptill and Zaza (2000) demonstrated that chronic upper extremity injuries and pain syndromes resulting from intensive piano practice can be successfully treated using multimodal therapy, including physiotherapy, psychotherapy, and modifications of playing technique, allowing musicians to fully restore their performance skills.

Preventive measures include not only restructuring daily practice routines (adequate rest breaks, proper warm-up and cool-down sessions) but also managing professional performance workload (appropriate programme difficulty, suitable repertoire). In this review, the term 'professional pianists' refers to individuals who have received formal musical training and are actively engaged in performance-related activities, such as concerts, competitions, or professional employment in music institutions. In contrast to amateur pianists, professionals are typically characterised by higher practice intensity and workload, often ranging from 4 to 8 hours per day, depending on performance demands and career stage. However, it should be noted that definitions of 'professional' vary across studies, and not all included studies explicitly distinguished between amateur and professional pianists (Academic Dictionaries and Encyclopedias, n.d.). A slow and controlled warm-up process involving light exercises has been shown to improve pianists' hand coordination and reduce the risk of injury. While physiotherapy methods are known to alleviate injuries, evidence on their effectiveness in injury management and prevention among professional pianists remains limited (Ling et al., 2018).

There is a lack of scientific publications and knowledge regarding physiotherapy (also referred to as physical therapy in some regions) interventions and methods for injury management and prevention among professional pianists. The available literature remains fragmented, heterogeneous, and limited in its systematic synthesis, particularly with regard to physiotherapy-related approaches (Altenmüller & Jabusch, 2010). While various preventive and rehabilitative strategies have been described, there is a lack of consolidated evidence mapping how physiotherapy methods are applied in the management and prevention of piano-related upper extremity injuries. This gap highlights the need for a scoping review to clarify existing concepts, interventions, and research directions in the professional pianist population (Semjonova & Litskevich, 2025).

2. METHODS

2.1. Type of review

This study was conducted as a scoping review. The aim of this study was to synthesise current evidence on physiotherapy methods used for the management and prevention of upper extremity injuries in professional pianists, as well as to identify key risk factors associated with these conditions. The review study was conducted from September 2024 to April 2025. The primary literature search was conducted on 29 September 2024, and an additional search was performed on 24 April 2025 to ensure the inclusion of the most recent studies. This review was conducted in accordance with the Joanna Briggs Institute (JBI) methodology for scoping reviews (Peters et al., 2022) and reported in accordance with PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines (Tricco et al., 2018). The protocol was registered in the Open Science Framework (Semjonova & Litskevich, 2025). The completed PRISMA checklist is provided in the appendix (see Appendix 1).

2.2. Search strategy

Scientific publications were identified from multiple databases: PubMed, Web of Science, EBSCOhost, MEDLINE Ultimate, and ProQuest. In addition, the reference lists of the identified publications were reviewed to locate further sources. Physical books published by Springer, Schattauer, Science & Medicine, Inc., The Planet of Music, Muzyka, and Salabert Editions were analysed. Books in German were accessed at the Medical University of Vienna library (AKH Wien, MedUni Wien) and also in electronic format when possible. Searches were initially conducted in November 2024 and updated in March 2025 to ensure the inclusion of the most recent publications. During the repeated search, no new relevant publications were identified. The search strategy was based on keywords defined in English according to the PCC framework. Synonyms were added for each keyword to ensure broad coverage of the literature. The initial search strategy was developed in PubMed (see Appendix 2) and then adapted to other databases, adjusting keyword combinations and filters as necessary.

The search strategy was based on keywords defined in English according to the PCC framework. Synonyms were added for each keyword to ensure broad coverage of the literature, using Boolean operator ‘OR’ (e.g. ‘physiotherapy’ OR ‘physical therapy’). Different concepts were combined using Boolean operator ‘AND’ (e.g. ‘pianists’ AND ‘upper extremity injuries’). The initial search strategy was developed in PubMed (see Appendix 2) and then adapted to other databases, adjusting keyword combinations and filters as necessary. Filters applied included: publications from the past 50 years; publications in English; publications from January 1, 1975, onward. The search strategy was designed to capture a comprehensive and diverse set of publications covering physiotherapy interventions, injury prevention, risk factors, and biomechanical causes related to pianists’ upper extremity injuries. The search strategy was developed in collaboration with a university-level academic librarian and refined through discussion and agreement between both authors. One author conducted the systematic search of electronic databases and manual searches of printed books and other relevant sources. All retrieved records were imported and managed using Microsoft Excel, where duplicates were removed and the screening process was conducted. During the screening process, the second author acted in a supervisory role and participated in the evaluation of identified records by independently and blindly assessing the applicability and eligibility of the included publications. Any uncertainties regarding inclusion were resolved through discussion between the authors.

2.3. Inclusion and exclusion criteria

The scoping review included scientific publications from the past 50 years focusing on professional pianists who have current or previous upper extremity injuries associated with piano playing. The eligibility criteria were defined based on the PCC (Population-Concept-Context) framework and the research questions. **Population (P):** Professional pianists with current or past upper extremity injuries related to piano playing. For the purposes of this review, a professional pianist was defined as an individual with formal piano education who engages in regular, structured practice and public performance as part of their professional activity (Kenny & Ackermann, 2015; Zaza & Farewell, 1997). This definition includes adult piano students (≥ 18 years) enrolled in higher music education institutions, performing pianists, and piano teachers whose professional duties involve extensive piano playing. **Concept (C):** Physiotherapy interventions for the management and prevention of upper extremity injuries. These interventions include evidence-based approaches aimed at restoring function, reducing pain, and preventing injury recurrence in pianists, such as manual therapy, therapeutic exercise, movement re-education, ergonomic guidance, and multimodal rehabilitation strategies tailored to the functional demands of piano performance. **Context (C):** Application of physiotherapy methods for pianists in clinical practice, educational settings, or home environments. This includes formal healthcare settings, higher music education institutions, and self-managed or supervised home-based programmes, reflecting the environments in which professional pianists, piano students, and piano teachers receive or apply physiotherapy interventions. According to the PCC framework, the keywords are summarised in Table 1.

Table 1. **Keywords and keyword sets according to the PCC framework**

Participants (P)	Context (C)	Concept (C)
Pianists; Professional pianists; Musicians; Adult piano students; Piano teachers	Upper extremity injuries; Musculoskeletal disorders; Overuse syndrome; Physiotherapy interventions; Rehabilitation; Injury prevention; Manual therapy; Therapeutic exercise; Ergonomics; Treatment	Clinical practice; Healthcare settings; Music education institutions; Conservatories; Home environment; Practice settings

Publications in English, German, French, Russian, and Ukrainian were considered. Articles in these languages were reviewed in their original form without translation, as the authors were proficient in these languages. The rationale for these criteria was to ensure a comprehensive overview of evidence relevant to injury management and prevention in pianists, capturing both clinical and educational contexts. The data source selection criteria are summarised in Table 2.

Table 2. **Data source selection**

Category	Inclusion Criteria	Exclusion Criteria
Participants	Adult participants (≥ 18 years); professional pianists, piano students, and piano teachers whose professional activity involves extensive piano playing; individuals with upper extremity injury symptoms (e.g. pain, swelling, muscle weakness, loss of coordination)	Non-pianist musicians; amateur musicians not meeting professional criteria; pianists without upper extremity injury symptoms; participants without relevant musical background

Category	Inclusion Criteria	Exclusion Criteria
Context	Publications addressing physiotherapy interventions for the management and prevention of upper extremity injuries (e.g. manual therapy, therapeutic exercise, stretching, soft tissue techniques, rehabilitation approaches); studies including risk factors and injury mechanisms (e.g. ergonomics, playing technique, workload, hand characteristics)	Publications not addressing physiotherapy interventions or injury-related outcomes; studies focusing on unrelated conditions or lacking relevance to upper extremity injuries in pianists
Concept	Publications included in clinical practice; rehabilitation settings; music education institutions; conservatories; home-based rehabilitation and practice environments	Contexts not related to health, rehabilitation, or piano performance environments
Study type/ Publication type	Publications from the last 50 years (since 1 January 1975); full-text articles and books; publications in English, German, French, Russian, and Ukrainian	Publications before 1 January 1975; full text not available

2.4. Data extraction and synthesis

Selection of sources of evidence was conducted in two stages:

- Primary screening: Publications were screened based on their titles and abstracts for relevance to the research topic. The initial screening focused on studies identified through keyword searches and their primary sources.
- Secondary screening: Full texts of publications were analysed. Publications without accessible full texts were searched in other databases, using the PRIMO search tool, or accessed via ResearchGate. Physical books were analysed when applicable. The selection process ensured that publications relevant to the PCC framework and research questions were included. Both electronic and physical sources were considered to maximise coverage of the literature.

Data charting process: Data were extracted from the included sources regarding upper extremity injuries in pianists, their causes, risk factors, physiotherapy interventions, and preventive strategies. A structured data charting process was followed based on three research questions. Data extraction was performed systematically, and the results were organised into tables and visual diagrams for clarity and comparability. This structured approach allowed for a comprehensive overview of findings and facilitated identification of patterns, trends, and gaps in the literature.

Data items: The variables for which data were sought included: Types of upper extremity injuries in pianists; Risk factors and biomechanical causes of injuries; Physiotherapy plans and methods for injury management; Preventive strategies and interventions for injury prevention.

The three research questions for data organisation:

1. What are the key risk factors and biomechanical causes of upper extremity injuries in professional pianists?

2. What physiotherapy interventions have been described for the management of upper extremity injuries in professional pianists?
3. What preventive strategies have been recommended to reduce the risk of upper extremity injuries in professional pianists?

Tables were used to present the data in a structured manner, allowing comparisons across studies and highlighting key findings related to pianists' health, injury management, and prevention.

Synthesis of results: Data were analysed descriptively based on the defined research questions.

The synthesis of results included:

- Presentation of risk factors and biomechanical causes of injuries;
- Description of physiotherapy plans and methods for injury management;
- Identification of preventive strategies for pianists.
- Tables and visual diagrams were used to summarise and organise the data, making patterns and trends across studies visible.

Special attention was given to secondary prevention, emphasising the development and maintenance of ergonomic piano-playing habits. The results highlighted opportunities for further research, including risk assessment, innovative interventions, and improvements in clinical practice for injury management and prevention.

2.5. Quality assessment

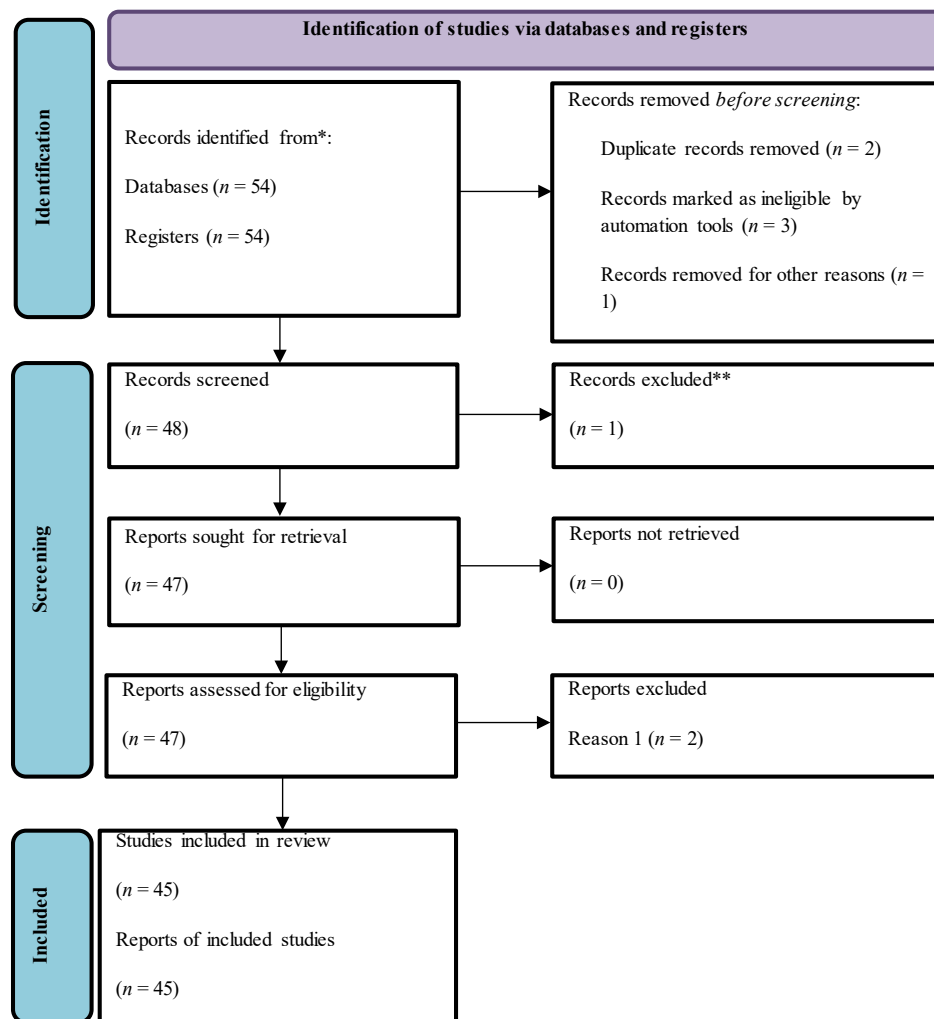
Critical appraisal of individual sources of evidence: No formal critical appraisal was conducted for the included sources of evidence. The purpose of the scoping review was to provide a descriptive overview of the available evidence rather than to evaluate the methodological quality of individual studies. The focus was on mapping the breadth and scope of research on physiotherapy methods and injury prevention for pianists.

2.6. Ethical considerations

This review used publicly available data; therefore, formal ethical approval was not required. The study adhered to ethical standards for research reporting and proper citation of all included sources.

3. RESULTS

The selection process initially focused on studies identified through keyword searches as well as their cited references. Publications for which the full text was not immediately available were searched in additional databases or accessed via the PRIMO search tool and the ResearchGate platform. Secondary sources included printed books, which were also available in digital format. Printed publications in German were obtained from the Medical University of Vienna library (AKH Wien, MedUni Wien). A total of 54 records were initially identified through database searches. Before screening, six records were removed – including two duplicates, three marked as ineligible by automation tools, and one excluded for other reasons (conference abstract only). After screening, 47 reports were assessed for eligibility. Of these, 45 studies were included in the final review as they met the predefined inclusion criteria and addressed the key research questions, while nine were excluded for not sufficiently aligning with the objectives of the study. The PRISMA flowchart summarising this process is presented in Figure 1.



* Records removed prior to screening included duplicates, records identified as ineligible by automation tools, and records excluded for other reasons. Records identified from databases (n = 54): PubMed (n = 23), Web of Science (n = 14), EBSCOhost (n = 12), ProQuest (n = 5). **conference abstract only.

Figure 1. **PRISMA flowchart diagram**

The included studies were predominantly observational, with cross-sectional designs being the most common, alongside a smaller number of interventional and descriptive studies. The evidence base was geographically diverse, with most studies originating from Europe and North America (e.g. the United States, Germany, France, and the United Kingdom), as well as contributions from Asia and other regions (Altenmüller & Jabusch, 2010; Belmarsh & Jardin, 1996; Bruno et al., 2006; Cortot, 1986, 2002; Furuya et al., 2006; Hofmann, 1961; Ling et al., 2018; Neuhaus, 1993; Savshinsky, 2021; Tchernik, 2017; Yoshimura et al., 2008). A summary of the main characteristics of the included studies is presented in Table 3. The review included peer-reviewed scientific articles, clinical studies, and printed books addressing the health of pianists and upper extremity disorders related to piano performance. Sources spanned the past 50 years (since 1 January 1975) and were published in English, French, German, Russian, and Ukrainian.

Table 3. Characteristics of all included studies

Study	Country	Study Design	Population	Main Focus
Ackermann (2002)	Australia	Observational	Musicians	Musculoskeletal health management
Ackermann & Chan (2014)	Australia	Review	Musicians	Physiotherapy management
Altenmüller & Jabusch (2010)	Germany	Review	Musicians	Focal dystonia, risk factors
Altenmüller & Kopiez (2010)	Germany	Case-based	Pianist	Chronic pain
Baadjou et al. (2018)	The Netherlands	Randomised controlled trial	Music students	Prevention
Berezutskyi & Berezutska (2020)	Ukraine	Review	Musicians	Overuse injuries
Belmarsh & Jardin (1996)	USA	Observational	Pianists	Upper extremity disorders
Bengston & Schutt (1992)	USA	Survey	Musicians	Musculoskeletal problems
Brandfonbrener (2003)	USA	Review	Musicians	Hand disorders
Bruno et al. (2006)	Italy	Cross-sectional	Piano students	MSD prevalence
Cortot (1986/2002)	France	Pedagogical	Pianists	Technique & injury prevention
Dawson (2006)	USA	Review	Musicians	Injury prevention
De Smet et al. (1998)	Belgium	Observational	Pianists	Overuse risk factors
Eijdsen-Besseling et al. (1993)	The Netherlands	Observational	Students	Posture
Farias et al. (2002)	Italy	Observational	Pianists	Hand anatomy
Fry (1988); Fry et al. (1998)	Australia	Clinical	Musicians	Overuse syndrome
Furuya et al. (2006)	Japan	Cross-sectional	Pianists	Risk factors
Green et al. (2000)	UK	Review	Musicians	Prevention
Guterman (1994)	Russia	Clinical	Pianists	Overuse injuries

Study	Country	Study Design	Population	Main Focus
Hochberg et al. (1983)	USA	Observational	Musicians	Hand disorders
Hofmann (1961)	USA	Pedagogical	Pianists	Technique
James et al. (2023)	France	Cross-sectional protocol	Students	Risk factors
Kahn et al. (1989)	France	Clinical	Musicians	Rheumatologic issues
Kenny & Ackermann (2015)	Australia	Observational	Musicians	Pain & anxiety
Ling et al. (2018)	Malaysia	Cross-sectional	Students	MSD prevalence
Neuhaus (1993)	Russia/UK	Pedagogical	Pianists	Technique
Revak (1989)	USA	Observational	Students	Upper limb discomfort
Rettig (2001)	USA	Clinical	Athletes/musicians	Overuse syndromes
Sakai & Shimawaki (2010)	Japan	Observational	Pianists	Movement analysis
Savshinsky (2021)	Russia	Pedagogical	Pianists	Practice hygiene
Sataloff et al. (2010)	USA	Clinical	Musicians	Performing arts medicine
Spahn et al. (2011)	Germany	Clinical	Musicians	Diagnosis & prevention
Tchernik (2017)	Canada	Thesis	Pianists	Technique & injury prevention
Van Reeth et al. (1992)	France	Clinical	Pianists	Hand pathology
Wu (2007)	USA	Systematic review	Musicians	Risk factors
Yoshimura et al. (2008)	USA	Cross-sectional	Piano teachers	Pain risk factors
Zaza (1994)	Canada	Review	Musicians	Prevention
Zaza & Farewell (1997)	Canada	Observational	Musicians	Risk factors
Ziesenitz (2023)	Germany	Clinical	Musicians	Physiotherapy

The publications provided information on:

- The incidence of upper extremity injuries in pianists;
- Risk factors and injury mechanisms, including ergonomics, piano technique, work routine, and anatomical features (e.g. hand size);
- Physiotherapy interventions for management and prevention, including manual therapy, stretching, strengthening exercises, soft tissue techniques, and multimodal approaches;
- Preventive strategies, including warm-up and cool-down routines, rest intervals, repertoire selection, and ergonomic piano-playing techniques.

A formal critical appraisal of methodological quality was not performed, consistent with JBI and PRISMA-ScR guidance (Peters et al., 2022; Tricco et al., 2018). Nevertheless, priority was given to peer-reviewed and authoritative publications, evaluated for relevance, methodological transparency, and consistency with the PCC framework.

The analysis revealed a high incidence of upper extremity musculoskeletal disorders in pianists, with pain, weakness, stiffness, and loss of coordination most frequently reported. Key risk factors included intensive playing schedules, repetitive movements, poor posture, technical errors, and individual anatomical characteristics.

Across the included studies, assessment of these conditions was most commonly based on self-reported questionnaires and surveys, while clinically oriented studies relied on physical examination and medical diagnosis. In addition, some studies applied observational methods, biomechanical analysis, and posture assessment to evaluate movement patterns and identify potential injury mechanisms. However, the use of standardised and validated assessment tools was limited, contributing to heterogeneity in the identification and reporting of upper extremity injuries. Physiotherapy interventions and preventive strategies, as described in the literature, consistently included manual therapy, stretching, strengthening exercises, multimodal approaches, ergonomic education, and appropriate practice planning. Findings were synthesised descriptively according to the research questions and presented in summary tables for clarity. Table 4 illustrates common types of upper extremity injuries in pianists and provides a context for analysing risk factors, physiotherapy interventions, and preventive strategies.

Table 4. Upper extremity injuries and conditions in professional pianists

Category	Condition/Injury	Description	Supporting Studies
Musculoskeletal Disorders	Tendinopathy Tendinitis	Forearm and finger flexor tendinitis; trigger finger	Hochberg et al., 1983; Altenmüller & Jabusch, 2010
Musculoskeletal Disorders	Epicondylitis	Lateral epicondylitis (tennis elbow)	Rettig, 2001; Sataloff et al., 2010
Musculoskeletal Disorders	Overuse syndrome	Repetitive strain injury	Hochberg et al., 1983; Fry, 1988
Musculoskeletal Disorders	Myositis	Muscle inflammation causing pain and weakness	Sataloff et al., 2010
Musculoskeletal Disorders	Tenosynovitis	De Quervain's tendon sheath inflammation	Rettig, 2001

Category	Condition/Injury	Description	Supporting Studies
Musculoskeletal Disorders	Ganglion cysts	Fluid-filled cysts near joints/tendons	Brandfonbrener, 2003
Musculoskeletal Disorders	Bursitis	Inflammation of bursae	Sataloff et al., 2010
Musculoskeletal Disorders	Shoulder pathologies	Rotator cuff injury, impingement	Ackermann, 2002; Sataloff et al., 2010
Musculoskeletal Disorders	Dupuytren's contracture	Progressive hand fascia tightening	Dawson, 2006; Spahn et al., 2011
Neurological Conditions	Nerve compression syndromes	Median, radial, ulnar nerve compression	Hochberg et al., 1983
Neurological Conditions	Focal dystonia	Involuntary muscle contractions	Altenmüller & Jabusch, 2010
Neurological Conditions	Neuropathies	Peripheral nerve dysfunction	Kahn et al., 1989
Chronic Degenerative Diseases	Osteoarthritis	Wrist joint degeneration (higher prevalence in elderly women)	Kahn et al., 1989
Chronic Degenerative Diseases	Rheumatoid arthritis	Inflammatory joint disease	Kahn et al., 1989
Chronic Degenerative Diseases	Psoriatic arthritis	Autoimmune joint inflammation	Kahn et al., 1989

3.1. Identified risk factors, biomechanical causes, and solutions for upper extremity injuries in professional pianists

Individual factors: Injury susceptibility varies among musicians and cannot be precisely predicted; adequate physical conditioning, ergonomic technique, and regular breaks significantly enhance endurance and efficiency. Small hand size, technical deficiencies, prolonged playing on heavy or stiff pianos, uncontrolled shoulder elevation, and inability to relax forearm and wrist muscles increase biomechanical overload. Effective warm-ups, tailored repertoire, scheduled rest, relaxation/stretching exercises, and musician education are critical preventive measures (Altenmüller & Jabusch, 2010; Ling et al., 2018; Savshinsky, 2021).

Daily pianist life: Pianists face intense schedules combining lessons, rehearsals, and performances, challenging health routines such as sleep, nutrition, and exercise. Achieving virtuosity often requires 6–8 hours of daily practice with short breaks, fostering discipline, focus, resilience, and artistic sensitivity. Regular performance enhances repertoire mastery and interpretive depth but also increases physical and cognitive demands, affecting overall health (Furuya et al., 2006; Neuhaus, 1993).

Contributing factors: Posture and seat height influence wrist positioning and upper limb load. Instrument type – grand piano vs upright – affects key resistance and finger force requirements, with manufacturer differences (e.g. Steinway, Bechstein, Petrof, Yamaha) further impacting biomechanical

stress. Lack of physical activity, prolonged static positions, and insufficient breaks exacerbate overload risk (Savshinsky, 2021; Tchernik, 2017).

Posture and body structure assessment: Professional pianists frequently exhibit postural imbalances, including forward head, increased thoracic kyphosis, scoliosis, shoulder asymmetry, and pelvic misalignment. Muscle strength and active scapular stabilisation is often insufficient, while repetitive key resistance induces muscle fatigue, impairing coordination (Belmarsh & Jardin, 1996; Cortot, 1986; Cortot, 2002).

Hand anatomy: Anatomical variations affect injury risk. Nerve compression syndromes are less common than tendinopathies. Pianists with smaller hands over-abduct and overextend the thumb to reach wide intervals, placing additional strain on flexors and hypothenar muscles. Small finger stiffness increases mechanical load during key depression, heightening upper extremity injury risk (Altenmüller & Jabusch, 2010; Belmarsh & Jardin, 1996; Ling et al., 2018).

Practice duration: While most pianists practice 2–3 hours daily, extended practice alone does not directly predict upper extremity injury. Injury risk rises with intensive learning of complex repertoire or prolonged sessions beyond the musician's technical capacity, emphasising the importance of technique-appropriate practice and repertoire selection (Furuya et al., 2006; Hofmann, 1961; Neuhaus, 1993).

Gender: Gender has also been identified as a relevant individual-level risk factor. Literature suggests that female pianists may report a higher prevalence of upper extremity musculoskeletal symptoms, attributed to anatomical, biomechanical, and workload-related factors, including differences in hand size, strength, joint laxity, and practice demands (Yoshimura et al., 2008).

Data on injury categories and identified risk factors are presented in Table 5 and Table 6. Although the primary focus of this review is on musculoskeletal conditions, these tables also include selected neurological conditions where they directly affect neuromuscular control, movement coordination, and musculoskeletal function, contributing to the development, persistence, or clinical presentation of upper extremity injuries in pianists.

Table 5. Risk factors for upper extremity injuries in professional pianists

Category	Risk Factor	Description	Supporting Studies
Non-Modifiable Physical Factors	Instrument type	Grand or upright piano characteristics	Zaza (1997); Ling et al. (2018)
Non-Modifiable Physical Factors	Anthropometric characteristics	Finger length, hand size	Wu (2007); Yoshimura et al. (2008)
Non-Modifiable Physical Factors	Sex and age	Biological and demographic factors	Zaza (1997); Kenny & Ackermann (2015)
Non-Modifiable Physical Factors	Joint hypermobility/previous injury	Predisposition to musculoskeletal strain	Sataloff et al. (2010)
Modifiable Physical Factors	Overuse	Prolonged practice or sudden workload increase	Zaza (1997); James et al. (2023)
Modifiable Physical Factors	Lack of rest	Insufficient breaks during practice	Ling et al. (2018); Sataloff et al. (2010)

Category	Risk Factor	Description	Supporting Studies
Modifiable Physical Factors	Poor posture	Ergonomic issues (e.g. seat height, shoulder elevation)	Yoshimura et al. (2008)
Modifiable Physical Factors	Playing technique	Inefficient or excessive mechanical load	Kenny & Ackermann (2015)
Modifiable Physical Factors	Lifestyle factors	Physical inactivity, poor sleep, nutrition	Wu (2007); James et al. (2023)
Modifiable Physical Factors	Inadequate prevention	Lack of guidance, teacher influence	Ling et al. (2018)
Psychosocial Factors	Performance anxiety	Anxiety before or during performances	Kenny & Ackermann (2015)
Psychosocial Factors	Competition	Pressure among musicians	Zaza (1997)
Psychosocial Factors	Personality traits	Perfectionism, high self-demand	Kenny & Ackermann (2015)
Psychosocial Factors	Stress environment	Work-related or external stress	Sataloff et al. (2010)
Psychosocial Factors	Mental health factors	Depression, low self-confidence	James et al. (2023)

3.2. The role of physiotherapy methods in injury management

Musicians recovering from injury, prolonged immobilisation, or surgery may experience limitations in joint range of motion (ROM), which can negatively affect instrument-specific performance. In pianists, restrictions in forearm pronation and supination are particularly relevant, as incomplete ROM may lead to compensatory hand movements during playing (Altenmüller & Jabusch, 2010; Zaza & Farewell, 1997). Earlier clinically oriented literature has described the use of manual therapy, passive joint mobilisation, and stretching to address ROM limitations, particularly when pain or stiffness restricts active movement (Altenmüller & Jabusch, 2010; Brandfonbrener, 2003; Cortot, 1986). However, contemporary physiotherapy practice places greater emphasis on active, exercise-based, and load-management approaches supported by current evidence. Across the reviewed literature, physiotherapy interventions commonly include concentric and eccentric strengthening exercises targeting the wrist and forearm flexors and extensors to address endurance demands associated with intensive and prolonged piano playing. Stretching is described in relation to maintaining muscle length and joint mobility, while proprioceptive training is reported to support joint position awareness in the context of overuse-related symptoms. Fine motor exercises are discussed in relation to finger coordination, precision, and ease of playing. In addition, relaxation-based approaches – such as massage, myofascial release, trigger point techniques, and diaphragmatic breathing – are described as supportive strategies for managing tissue tension and shoulder girdle discomfort. Physical modalities, including ultrasound, cryotherapy, paraffin application, magnetotherapy, TENS, and hydrotherapy, are reported as adjunctive components of rehabilitation programmes (Ackermann & Chan, 2014; James et al., 2023). Stretching approaches, including static stretching and proprioceptive neuromuscular facilitation (PNF), are described as being applied to maintain joint mobility, with some clinical reports combining stretching with orthotic support in con-

ditions such as lateral epicondylitis and De Quervain's tenosynovitis (Altenmüller & Jabusch, 2010; Cortot, 1986). Soft tissue techniques – such as massage, ischemic compression, myofascial release, Shiatsu, and Bowen therapy – are also reported in relation to the management of painful, tight, or fibrotic tissues and are typically described alongside active mobility, strengthening, and stability exercises. Physical modalities including TENS, ultrasound, interferential therapy, and acupuncture are mentioned for symptom modulation, although evidence regarding their long-term effectiveness remains limited (Altenmüller & Jabusch, 2010; Sataloff et al., 2010). The importance of relative rest and gradual return to playing is emphasised across the literature, with prolonged absolute rest discouraged due to the risk of joint stiffness, muscle atrophy, and delayed recovery (Fry, 1998). Some sources also refer to medical or surgical interventions, such as corticosteroid injections or surgery, when conservative management is unsuccessful; however, these approaches fall outside the scope of physiotherapy and are included only to contextualise broader management pathways (Altenmüller & Jabusch, 2010). In response to the second research question, Table 6 summarises the physiotherapy interventions identified across the included studies, including therapeutic exercise, manual therapy, movement re-education, ergonomic strategies, and multimodal rehabilitation approaches.

Table 6. Identified physiotherapy methods in the management of upper extremity injuries in professional pianists

Physiotherapy Intervention	Description	Supporting Studies
Manual therapy and mobility techniques	Joint and soft tissue mobilisation to improve range of motion	Sataloff et al. (2010); Van Reeth et al. (1992)
Proprioceptive neuromuscular facilitation (PNF)	Neuromuscular techniques to enhance coordination and control	Sataloff et al. (2010)
Therapeutic exercises	Targeted exercises to restore function and reduce injury risk	Sataloff et al. (2010); Baadjou et al. (2018)
Muscle strengthening	Progressive resistance training to improve load tolerance	Sataloff et al. (2010)
Soft tissue techniques	Myofascial release and muscle relaxation techniques	Van Reeth et al. (1992); Sataloff et al. (2010)
Neuromuscular re-education	Motor control and coordination training	Van Reeth et al. (1992)
Proprioception training	Exercises to improve joint awareness and stability	Van Reeth et al. (1992)
Ergonomic training	Optimisation of posture, seating, and playing technique	Sakai & Shimawaki (2010); Guterman (1994)
Use of orthoses (adjunct)	Supportive devices to reduce mechanical strain	Sakai & Shimawaki (2010); Sataloff et al. (2010)

3.3. Identified solutions for upper limb injury prevention in professional pianists

The most conservative approach to preventing upper limb injuries in pianists is modification of playing technique. Surveys indicate technique adjustments are the second most effective preventive method after relaxation techniques (Belmarsh & Jardin, 1996; Cortot, 1986). Pianists should attend to pain, fatigue, stiffness, or discomfort, as these may signal overuse syndrome. Early intervention with rest and ergonomic adjustments – particularly avoiding shoulder elevation during playing – can prevent progression. Scheduled breaks, warm-up and cool-down exercises reduce musculoskeletal overload and injury risk (Ling et al., 2018; Altenmüller & Jabusch, 2010).

Pianist ergonomics: Proper seating height and hand positioning must suit individual body proportions (Cortot, 1986; Savshinsky, 2021). The elbow should be slightly above the wrist, with the wrist in a neutral, relaxed position. Tension or unnatural postures increase fatigue, stiffness, and injury risk. Maintaining freedom of movement and a relaxed body posture ensures efficient technique and reduces overuse (Hofmann, 1961; Lhevinne, 1972).

Individualised technique: No universal method guarantees safety or effectiveness; technique must reflect instrument characteristics, repertoire, anatomical differences, and personal physical and emotional traits (Altenmüller & Jabusch, 2010). Three key factors for healthy playing are: Pianist's posture at the instrument; Musculoskeletal demands of piano playing; Repertoire- and exercise-related risks. Historical pedagogical sources (Savshinsky, Cortot, Neuhaus) provide detailed guidance on posture, movement organisation, and injury prevention. Schmidt-Shklovskaya's exercise system develops finger independence, lightness, and flexibility, effectively treating 'overplayed hand' issues (Brandfonbrener, 2003). Guterman (1994) highlighted that overuse injuries largely result from incomplete technique (Brandfonbrener, 2003; Cortot, 2002; Guterman, 1994; Ling et al., 2018; Neuhaus, 1993; Savshinsky, 2021). Incorrect technique must be identified and corrected, ideally through collaboration between the music teacher and a healthcare professional. Even pianists with the 'perfect' technique can suffer injuries if practice load increases too rapidly. Ergonomic posture, regular breaks, and physical conditioning are essential to prevent biomechanical imbalance and overuse injuries (Ackermann & Chan, 2014).

Taken together, the findings indicate that injury prevention in professional pianists is multifactorial, involving biomechanical, behavioural, and educational components. While empirical studies provide evidence on physical and ergonomic risk reduction strategies, historical pedagogical sources offer detailed and practice-oriented insights into technique development, movement efficiency, and long-term injury prevention. Therefore, Table 7 presents a structured synthesis of preventive strategies identified in both the scientific literature included in this review and relevant pedagogical sources. The strategies are grouped into thematic categories to improve clarity and to distinguish between physiotherapy-based, behavioural, ergonomic, and pedagogical approaches.

Table 7. Preventive measures and recommendations for professional pianists

Category	Preventive Strategy	Description	Supporting Sources
Ergonomic/ Physical	Proper playing posture	Neutral wrist, correct seating height, avoid shoulder elevation	Ling et al. (2018); Altenmüller & Jabusch (2010); Hofmann (1961); Lhevinne (1972)
Ergonomic/ Physical	Technique optimisation	Efficient movement, reduced muscular tension	Ackermann & Chan (2014); Van Reeth et al. (1992)

Category	Preventive Strategy	Description	Supporting Sources
Behavioural	Practice load management	Scheduled breaks, gradual workload increase	Zaza (1994); Ling et al. (2018); Fry (1988)
Behavioural	Warm-up and cool-down	Preparation and recovery of musculo-skeletal system	Ling et al. (2018); Altenmüller & Jabusch (2010)
Behavioural	Early symptom monitoring	Recognition of pain and fatigue	Dawson (2006); Ling et al. (2018)
Physical Conditioning	Complementary physical activity	Strength and endurance training	Zaza (1994); Green et al. (2000)
Pedagogical	Individualised technique training	Adaptation to anatomy and repertoire	Neuhaus (1993); Savshinsky (2021); Altenmüller & Jabusch (2010)
Pedagogical	Teacher guidance	Development of correct technique habits	Neuhaus (1993); Guterman (1994)
Pedagogical	Analytical practice approach	Avoidance of repetitive strain	Neuhaus (1993)
Pedagogical	Technical exercises	Finger independence, flexibility, endurance	Tchernik (2017); Savshinsky (2021)

4. DISCUSSION

4.1. Prevalence and risk factors

This scoping review aimed to synthesise evidence on the prevalence, risk factors, and management of upper extremity injuries in professional pianists. The findings indicate that these injuries are highly prevalent and multifactorial in nature. The reported incidence varies considerably across studies, with estimates ranging from 25% to 93% in professional pianists and 30–60% among music students (Ling et al., 2018), suggesting variability in study populations, definitions, and assessment methods. This variability highlights the lack of standardised diagnostic criteria in this field.

The classification of these conditions into neuromusculoskeletal disorders, overuse syndromes, and degenerative diseases is consistent with previous literature (Belmarsh, 1996; Ling et al., 2018). The high proportion of overuse-related conditions, accounting for approximately 42% of hand pathologies (Hochberg et al., 1983), further emphasises the role of repetitive mechanical loading in injury development.

The identified biomechanical risk factors – including small hand size, inadequate technique, prolonged playing, and poor postural control – are consistent with previous findings (Ackermann, 2002; Altenmüller & Jabusch, 2010; Wu, 2007). These results support the view that both individual anatomical characteristics and modifiable behavioural factors contribute to injury risk. Importantly, the findings sug-

gest that inadequate technique and poor ergonomic habits may amplify the effects of inherent anatomical limitations, indicating a strong interaction between modifiable and non-modifiable factors.

Education of pianists and teachers in ergonomics and correct playing technique emerges as a key factor in reducing injury risk and supporting long-term career sustainability. This aligns with previous studies emphasising the importance of early pedagogical intervention and technique development (Ackermann, 2002; Altenmüller & Jabusch, 2010). These findings highlight that injury prevention is not solely a clinical issue but also a pedagogical one.

4.2. Physiotherapy interventions and treatment

The findings of this review indicate that the management of upper extremity injuries in pianists requires a multidisciplinary and individualised approach. While earlier literature often emphasised rest and passive treatments, the current synthesis suggests a shift towards active, exercise-based physiotherapy strategies. Interventions such as movement re-education, proprioceptive training, and strengthening exercises are increasingly highlighted, reflecting contemporary physiotherapy principles (Ackermann & Chan, 2014).

This is consistent with broader musculoskeletal rehabilitation literature, where active approaches are preferred over passive modalities. At the same time, passive treatments such as manual therapy and soft-tissue techniques are still described as supportive components rather than primary interventions. The use of physical modalities (e.g. cryotherapy) appears mainly focused on short-term symptom relief rather than long-term functional recovery.

The findings also underscore the importance of interdisciplinary collaboration between health-care professionals and music educators. This reflects a growing recognition that effective rehabilitation must address not only physical impairments but also technique, workload, and performance-related demands.

4.3. Preventive strategies

The results highlight that preventive strategies are strongly centred on ergonomics, technique, and workload management. Regular warm-up and cool-down routines, appropriate rest breaks, and structured practice schedules are consistently recommended across the literature (Ling et al., 2018; Savshinsky, 2021). These findings support existing evidence that overuse injuries are closely linked to cumulative load and insufficient recovery.

Importantly, the role of pedagogical guidance emerges as a central preventive factor. Teacher involvement in developing correct technique, posture, and body awareness is consistently emphasised. This supports the perspective that prevention should begin early in musical training and be integrated into the educational process rather than addressed only after injury occurs.

The importance of individualised technique is also highlighted, as anatomical differences between pianists require tailored approaches to movement and repertoire selection. This reinforces the idea that there is no single optimal technique, but rather a need for adaptive and personalised strategies.

4.4. Implications for education and practice

The findings of this review suggest that an integrated, multidimensional approach is essential for both prevention and management of upper extremity injuries in pianists. Combining physiotherapy, ergonomic principles, technical training, and education provides a more comprehensive strategy than isolated interventions.

These results have important implications for both clinical practice and music education. For clinicians, they highlight the need to consider instrument-specific demands and collaborate with music educators. For educators, they emphasise the importance of incorporating health-related knowledge into teaching practice. The review therefore serves as a bridge between healthcare and music pedagogy.

4.5. Limitations and future directions

This scoping review included publications spanning the past 50 years, with older sources interpreted cautiously. The heterogeneity of study designs, populations, and outcome measures limits the ability to draw definitive conclusions regarding the effectiveness of specific interventions. In particular, the lack of high-quality experimental studies highlights a significant gap in the literature.

A key limitation of this review is the lack of consistent definitions of ‘professional pianists’ across the included studies. This issue reflects broader limitations in the field and necessitated broader inclusion criteria, which may affect the generalisability of the findings.

Future research should focus on high-quality, standardised studies investigating physiotherapy interventions within multifactorial prevention and treatment models. There is also a need for validated assessment tools and clearer definitions of study populations to improve comparability across studies.

5. CONCLUSIONS AND PERSPECTIVES

Upper extremity injuries among pianists represent a widespread problem, primarily affecting professional pianists. The main risk factors include insufficient technical foundation (such as postural alterations, including shoulder elevation), pathological and prolonged overuse, lack of pedagogical competence, psycho-emotional stress and unfavourable work environment, improper work organisation, and long-term disregard of ergonomic principles.

An effective physiotherapy plan requires a multidisciplinary approach, combining physiotherapy, ergonomic principles, and appropriate work organisation to support both injury management and prevention. The findings of this scoping review indicate that physiotherapy is most commonly implemented as part of a broader, multifactorial, and interdisciplinary approach, frequently combined with pedagogical guidance, ergonomic modification, psychosocial support, and wellness strategies.

Preventive measures primarily involve the reduction or modification of identified risk factors, including the development of a correct technical foundation and the application of ergonomic principles, thereby reducing the likelihood of upper extremity injuries in professional pianists. Insufficient attention to preventive strategies and early symptoms may lead to the progression of overuse syndrome into more specific disorders, increasing the complexity of treatment.

However, due to the heterogeneity of study designs and the frequent use of combined interventions, the effectiveness of isolated physiotherapy interventions and preventive strategies cannot be clearly determined based on the current literature.

Author Contributions: Conceptualisation, E.L. and G.S.; methodology, G.S. and E.L.; software, E.L. and G.S.; validation, E.L. and G.S.; formal analysis, E.L.; investigation, E.L. and G.S.; resources, E.L.; writing—original draft preparation, E.L.; writing—review and editing, G.S.; visualisation, E.L.; supervision, G.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Acknowledgements: I (E.L.) would like to extend gratitude to all my professors and teachers in the field of piano performance from the Emīls Dārziņš Music School and the Jāzeps Vītols Latvian Academy of Music – especially Artūrs Cingujevs, Dr. art. (Moscow), M.A. in Music Performance (Bern), M.A. in Arts (Riga), who have guided and supported me throughout my years of study. Their dedication, knowledge, and encouragement have been invaluable in helping me reach a high level of performance. I would like to express special appreciation to my first teacher at the children’s music school, Gabriela Černavska, M.A. in Music Performance, M.A. in Pedagogy, whose early mentorship laid the foundation for my musical journey and instilled in me a lasting passion for the piano. This work would not have been possible without my extensive experience in the field of piano performance and concert practice, combined with my academic training in physiotherapy. Drawing on years of practical engagement as a pianist, coupled with a clinical understanding of the human body, a comprehensive perspective on injury prevention and management has been developed, specifically tailored to the needs of professional pianists.

Conflicts of Interest: The authors declare no conflict of interest.

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Received 2026 02 17

Accepted 2026 04 01

APPENDIX 1

Attachment 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	84
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	84
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	85
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g. population or participants, concepts, and context) or other relevant key elements used to conceptualise the review questions and/or objectives.	85
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g. a Web address); and if available, provide registration information, including the registration number.	86
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g. years considered, language, and publication status), and provide a rationale.	87
Information sources*	7	Describe all information sources in the search (e.g. databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	86
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	86
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e. screening and eligibility) included in the scoping review.	88
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g. calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	88
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	88
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	89

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarising the data that were charted.	89
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	89–90
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	91–92
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	93
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	94–99
Synthesis of results	18	Summarise and/or present the charting results as they relate to the review questions and objectives.	99–101
DISCUSSION			
Summary of evidence	19	Summarise the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	101
Limitations	20	Discuss the limitations of the scoping review process.	101
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	101
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	101

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g. quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of 'Risk of Bias' (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g. quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., ... Straus, S. E. (2018). PRISMA extension for Scoping Reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, 169(7), 467–473. <https://doi.org/10.7326/M18-0850>

APPENDIX 2

The PubMed search strategy was developed in accordance with the PCC (Population – Concept – Context) framework and combined Medical Subject Headings (MeSH) terms with free-text keywords. Boolean operators (AND/OR) were used to ensure comprehensive coverage.

((pianist*[Title/Abstract] OR piano[Title/Abstract] OR musician*[Title/Abstract] OR “keyboard player*”[Title/Abstract])) AND ((“physiotherapy”[Title/Abstract] OR “physical therapy”[Title/Abstract] OR rehabilitation[Title/Abstract] OR “manual therapy”[Title/Abstract] OR exercise[Title/Abstract] OR “exercise therapy”[Title/Abstract] OR “isometric exercise*”[Title/Abstract] OR stretching[Title/Abstract])) AND ((“upper extremity”[Title/Abstract] OR “upper limb”[Title/Abstract] OR hand[Title/Abstract] OR wrist[Title/Abstract] OR forearm[Title/Abstract]) AND (injur*[Title/Abstract] OR “musculoskeletal disorder*”[Title/Abstract] OR overuse[Title/Abstract] OR “overuse syndrome”[Title/Abstract] OR tendinopathy[Title/Abstract] OR tendinitis[Title/Abstract] OR “repetitive strain injury”[Title/Abstract]))

Filters applied: Publication date: 1 January 1975 – present; Language: English; Species: Humans