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RESEARCH ARTICLE

A systematic review of playing-related musculoskeletal disorders (PRMD) among tertiary-level professional music students: Exploring gender, psychological, and physiological determinants.

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ABSTRACT

Objective: The aim of this systematic review was to assess the methodological quality of articles on the prevalence of playing-related musculoskeletal disorders (PRMD) in music students tertiary, and to determine the prevalence rate and associated factors of PRMD.

Methods: This review included crosssectional studies that described data on music students and were published in English between 1/1/2000 and 9/20/2024. Databases used in this study included, Web of Science (core collection), MEDLINE, sciELO, PubMed and Scopus. Reviewers used the Loney scale to assess methodological quality, and only studies that scored 5 were included.

Results: A total of 479 articles have been identified, among which 11 cross - sectional studies were selected for methodological assessment. All of these studies achieved satisfactory scores regarding methodological quality. The prevalence rate of PRMD was remarkably high, varying from 28.9% to 80.7%. Female student musicians were more susceptible compared to those of other genders. Students lacking exercise habits were at higher risk. String and keyboard instrument players had the highest probabilities of PRMD. The traits of anxiety and perfectionism among music students were closely associated with PRMD.

Conclusions: Music students are generally affected by PRMD. The gender, exercise habits and emotional traits of students are highly correlated with PRMD. Low response rates are a prevalent issue, and researchers from different continents tend to use different survey tools.

Keywords: Musculoskeletal disorders; music student; female; risk factors, prevalence

1. Introduction

Playing-related musculoskeletal disorders (PRMD) have attracted increasing interest from researchers over the past few decades. Initially, research into PRMD focused on professional musicians, with the aim of establishing the prevalence and impact of musculoskeletal problems resulting from rigorous performance schedules and extensive rehearsal periods. As an occupational issue relevant to musicians, the genesis of research into PRMD can be traced back to the experiences of notable musicians throughout history. Throughout its history, PRMD has been characterised by its broad coverage of instrument types and its

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continuing impact on musicians' performance activities. It has affected many famous musicians, including pianists with relatively symmetrical playing positions such as Glenn Gould,[1] who suffered from back and shoulder injuries, and Clara Schumann,[2] who suffered from arm injury, and the celebrated violinist Hilary Hahn,[3] who played his instrument in an asymmetrical posture, have been documented to have experienced the effects of PRMD, which in turn affected their interpretations of musical works and resulted in the premature termination or cessation of their careers.[4]

Over time, the focus of research on PRMD has not only encompassed professionals, but has also gradually expanded to include a specific group of music students. Music students have been recognized as a particularly vulnerable group due to the intense practice demands of technological development and the stresses associated with music education.[5] By the beginning of the 21st century, researchers noted significantly higher rates of PRMD among music students, despite the fact that their performance careers may be shorter,[6] prompting an increased academic focus on understanding the risk factors facing this group, including the effects of psychological stress, perfectionist tendencies, and music performance anxiety (MPA).[7] As a result, research has begun to explore both physical and psychological dimensions in an effort to more fully analyze the causes of PRMD in the student population.[8]

This systematic review therefore seeks to address this critical literature gap by synthesizing cross-sectional studies from around the world on PRMD prevalence among music students. In view of the persisting difficulties in grasping the scope and contributing factors to PRMD, a comprehensive analysis is required to consolidate current knowledge and identify consistent risk factors. This review, therefore, will contribute to the development of evidence-based practices that explain the prevalence and risk factors to help offer a better health outcome for music students in relation to their academic and professional success. Meanwhile, by using research quality tools to assess the methodological quality of the studies that meets the inclusive standards, the methodological quality deficiencies of the existing studies are identified, providing valuable suggestions for future similar research.

2. Methods

Only high-quality cross-sectional studies were included in this review. This study selection strategy ensured that the included studies had the same methodological characteristics and were particularly suitable for estimating prevalence in the same population in similar learning environments, while ensuring methodological consistency, making the review literature more comparable, and maximizing the presentation of the prevalence and severity of PRMD among a large number of music students under relatively uniform study criteria. To this end, the development of highly rigorous inclusion criteria for the study design was one of the strategies employed in this review to minimise heterogeneity and ensure that the results of the studies provided a clear and consistent picture of the prevalence of PRMD based on evidence-based conclusions.[9,10]

2.1. Search strategy

In order to comprehensively investigate the prevalence of PRMD and associated risk factors among music students, we executed detailed searches in multiple academic databases (WoS, PubMed, and Scopus). The range of studies that potentially met the inclusion criteria for this study from January 1, 2000 to September 20, 2024 was obtained. This was a multi-database approach that was hoped to encompass different disciplines and fields such as musculoskeletal health, music education and occupational health. The strategy includes synonyms and similar terms including " musculoskeletal disorders* " , " PRMD " , "musculoskeletal pain", "student musician," and 'music student' among other phrases. Appropriate use of Boolean operators and wildcards broadened the search and ensured the relevance of the results.[11]

The search strategy for Web of Science was devised to perform the search on Web of Science Core Collection, MEDLINE, and SciELO Citation Index databases for an interdisciplinary multi-language literature review. By using the TS field tag, which searches titles, abstracts, and keywords, keywords like "musculoskeletal disorder*," "PRMD," and "musculoskeletal pain" were combined with population descriptors such as "student musicians" and "music students." These were then combined by using the Boolean operator "OR" with words such as "prevalence," "incidence," and "risk factors" to further narrow the search toward epidemiological concerns. A similar search syntax was utilized in PubMed but adapted to accommodate the unique search functionality of PubMed. Primary terms were "Playing-Related Musculoskeletal Disorders" and "musculoskeletal disorders" combined with population and epidemiological keywords to maximize the capture of a variety of studies. In Scopus, this search strategy utilized the field tag TITLE-ABS-KEY to capture, respectively, titles, abstracts, and keywords, including terms such as "musculoskeletal disorder*," "performance injury," and "musculoskeletal pain," combined with terms and descriptors such as "music student*" and "student musician*." Other terms have been added, like "risk factor*," in order to cover a wide range of possible influences.

2.2. Search Strings

(“Music Student*” OR “Student Musician*” OR “Instrumentalist*” OR “College Music Student*” OR “University Music Student*” OR “Undergraduate Musician*” OR “Musicians”)

AND

(“Playing-Related Musculoskeletal Disorder*” OR “PRMD” OR “Musculoskeletal Disorder*” OR “Cumulative Trauma Disorder*” OR “Overuse Injury*” OR “Occupational Musculoskeletal Disorder*” OR “Repetitive Strain Injury” OR “RSI”)

AND

(“Prevalence” OR “Incidence” OR “Epidemiology” OR “Risk Factor*” OR “Survey” OR “Cross-Sectional Study” OR “Cohort Study” OR “Prospective Study”)

2.3. Inclusion criteria

The inclusion criteria for this systematic review were carefully developed to ensure that only high-quality relevant studies addressing the prevalence of PRMD among music students were considered. This review focuses only on cross-sectional studies as they provide nodal data on the prevalence of PRMD in a specific population, excluding other study designs such as cohort or case-control studies in order to maintain consistency of research methodology. The target population was limited to mature music students, i.e., individuals aged 18 years or older actively pursuing a formal music education program at a university or equivalent institution of higher education. By setting this age threshold, the review specifically targeted university or pre-professional students and excluded younger amateur musicians in order to focus on key stage music students who are undergoing rigorous formal training.

Studies must report the prevalence of PRMD or the frequency of musculoskeletal discomfort directly related to play-related activities. Eligible studies provide definitive measures of PRMD affecting specific body regions (e.g., upper extremities, spine, or neck) or report whole-body prevalence. These outcomes must be assessed by reliable methods, including validated self-report questionnaires or targeted scales developed for research that explicitly focus on musculoskeletal health. In addition, only studies published in peer-reviewed journals were considered for this study to ensure the rigor and credibility of the findings. The language of publication was limited to English to allow for standardized data extraction and further interpretation. If a study included a subset of participants in a larger, more diverse sample that met the

inclusion criteria, only data specifically related to the subset of adult music students were extracted and analyzed, provided that these results had been explicitly and independently reported in the study.

2.4. Exclusion criteria

The exclusion criteria for this systematic review were likewise carefully discussed to exclude studies that were inconsistent with the specific focus on adult music students and PRMD. Studies involving amateur musicians, high school students, or college students not enrolled in a full-time music program were excluded because these groups are not part of the target population of professional or pre-professional musicians who receive formal training with systematic regularity. Similarly, studies that targeted specific music student populations such as marching band music students were excluded because the demands placed on students in these programs differ significantly from those placed on students in traditional music programs.

Studies unrelated to health status, such as those assessing purely physical parameters not directly related to PRMD, were also excluded to maintain the specificity of the review. Methodologically, case studies, qualitative studies, systematic reviews, and randomized controlled trials were excluded, as this review focuses only on cross-sectional studies that provide prevalence data.

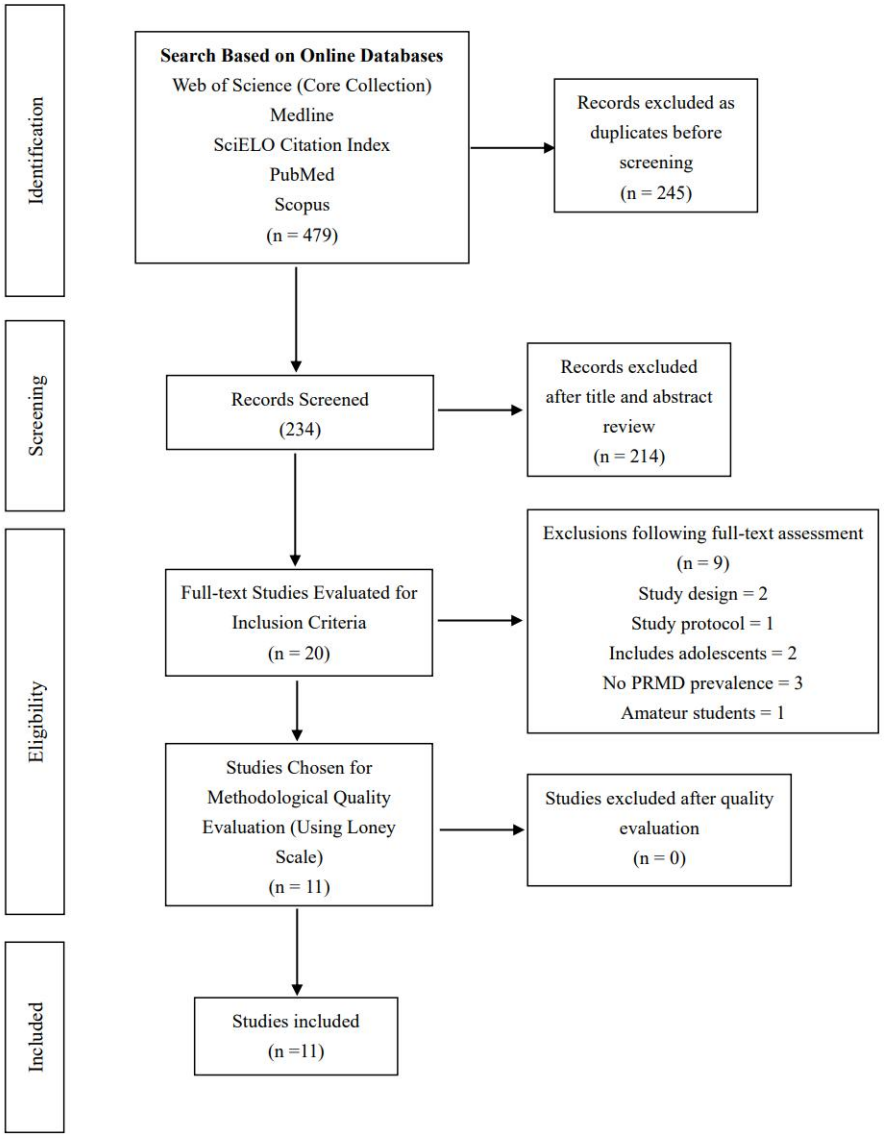

Figure 1. PRISMA flowchart and study selection process.

The study selection process adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure a systematic and transparent approach in identifying relevant literature on the prevalence and risk factors associated with PRMD among adult music students.[12,13] This systematic review involved comprehensive searches across multiple academic databases, including Web of Science, PubMed, Scopus, and Google Scholar. Our search strategy was designed to encompass a broad array of relevant terms, targeting studies from 2000 to September 20, 2024 that addressed PRMD prevalence among university-level or professional music students.

During the "identification" phase, an initial database search generated a large number of records that were identified as potentially relevant studies. Subsequently, we removed duplicate entries to ensure that each citation represented a unique study. At this stage, there remained a large number of records that required further screening based on our predetermined inclusion and exclusion criteria.

During the screening phase, the titles and abstracts of the remaining records were reviewed. Studies that clearly did not meet the eligibility criteria were excluded, including those that focused on target student populations such as middle school students, high school students, amateur musicians, or populations that did not meet the age threshold for adults 18 years and older.

The full text of the remaining articles was assessed in detail at the eligibility stage based on inclusion and exclusion criteria. Studies had to use a cross-sectional design with adult music students participating in formal music education and report PRMD incidence as the primary outcome. Articles using a qualitative research design, case studies, randomized controlled trials, or articles providing only descriptive statistics without in-depth analysis were excluded at this stage. Studies were also excluded if they used only simple t-tests or correlations for basic comparisons, as these methods were not sufficiently rigorous.

About the stage of Inclusion, studies that met all the criteria were integrated into the systematic review. These studies provided comprehensive data regarding PRMD prevalence among adult music students and were then subjected to a methodological quality assessment to ensure that the standards for robust analysis were met. The PRISMA flow diagram summarized in **Figure 1** shows each stage of selection from identification to the final selection of studies included in this review.

2.5. Data extraction

Data extraction in this systematic review was done by a single reviewer to ensure that information on the studies included in this study was collected in a nonbiased and uniform standard. Key data points extracted included author name, geographic location, sample size, response rate, and characteristics of the study population.

Consequently, special attention has been paid to the prevalence of PRMD as reported in each case under study. Data on the following have been extracted: an itemized review was made concerning the methodologies adopted in data gathering in reviewed studies, including items with respect to whether standardized and reliable instruments have been used to assess musculoskeletal symptoms. Outcomes from each single study were documented while carefully paying attention to demographic factors of age, gender, and type of instrument played.

2.6. Methodological quality evaluation

Table 1. Evaluation of methodological quality of included studies.

Reference	1	2	3	4	5	6	7	8	Total score
Zão et al., 2024	1	1	1	1	1	1	1	1	8
Z'Graggen et al., 2024	1	1	0	1	1	0	1	1	6
Ling et al., 2018	1	1	0	1	1	0	1	1	6
Steinmetz et al., 2010	1	1	0	1	1	0	1	1	6
Rodríguez-Romero et al., 2016	1	1	0	1	1	0	1	1	6
Lonsdale & Boon, 2016	1	1	0	1	1	0	0	1	5
Árnason et al., 2014	1	1	0	1	1	0	0	1	5
Cruder et al., 2020	1	1	1	1	1	0	0	1	6
Kok et al., 2015	1	1	0	1	1	0	0	1	5
Ballenberger et al., 2023	1	1	0	1	1	0	0	1	5
Stanek, et al., 2017	1	1	1	0	1	0	0	1	5

Loney Scale Scoring Criteria: This score is adapted from the Loney Scale in that each item is scored as 1 for "yes" and 0 for "no". Items scored are as listed below: 1) Was the study population appropriately selected? 2) Was the sampling framework unbiased? 3) Was the sample size (music students) adequate exceeding 300 participants? 4) Were standardized measurement tools employed? 5) Were outcomes measured by unbiased assessors? 6) Response rate was adequate (≥70%), and non-responders were described. 7) Confidence intervals and subgroup analyses were presented. 8) Study subjects were described. The total score according to these criteria is compiled in the assessment of overall quality.

The current systematic review excludes studies scoring below 5 on the Loney Scale.[16] This was necessary to acquire methodological strength so that the evidence presented can be valid and reliable.[14,15] The Loney Scale addresses the key components of determining quality: sampling method, reliability of measurements, blind assessors, and response rate. Since a threshold score was established, there was limited risk of bias, and conclusions from such an analysis can be assured to be based on robust and high-quality data.[16,17] This is particularly critical in exploring PRMD among music students, since any weakness in methodology might have considerable consequences on the validity of the findings.[18] Attention is focused on higher-scoring studies to enhance internal consistency and credibility of review.

After discussion, we decided to include studies that rated 5 on the Loney Scale, and in doing so, we aimed to broaden the scope and depth of the evidence base. The reasons for the relatively low ratings of these studies centered on items such as small sample size, failure to report response rates, and failure to provide confidence intervals. Despite some methodological flaws in these studies, they are still considered research-worthy because they also help us understand the level of PRMD among music majors, and some of the studies make unique contributions to certain line items.[19,20,21]

On the other hand, the inclusion of studies with smaller sample sizes enables niche populations or specific subgroups to be covered.[22] These populations or subgroups are often underrepresented in larger studies. There are unique challenges to recruiting large numbers of participants in music-related studies, especially when regional or professional contexts are involved, which often makes it difficult to exceed sample sizes of 300. Music student populations are often small and dispersed, so studies that may fall short of ideal sample size requirements can still provide key insights into different music disciplines, geographic regions, and cultural contexts. This richness and diversity of evidence serves to minimize the potential bias that may arise from relying solely on large studies, which may not adequately capture the experiences of all subgroups of the target population.

Similarly, the lack of information on response rates and confidence intervals limits the precision and generalizability of individual studies, but it does not negate the potential value of the findings from a broader perspective. By synthesizing the results of such studies with those of higher-scoring studies, this review aims to provide a more comprehensive overview of the current state of research.

3. Results

This systematic review encompasses 11 studies, all of which explore PRMD among music students. What is particularly important is how these cross-sectional studies bring significant depth to the key findings on PRMD prevalence, the associated risk factors, and its impact upon a music student population in a variety of settings.

3.1. Prevalence of playing-related musculoskeletal disorders

Among the studies, the prevalence for PRMD was likewise highly variable, ranging from 28.9% to 80.7%. The lowest prevalence was that among the Malaysian instrumental music students and the highest prevalence among European Music Academy and Icelandic music students.[19,21] This may be partly explained by the differences in sample size, study design, and the definition of PRMD used for each of these studies. For example, the study by Beatriz documented a 47% prevalence of musculoskeletal pain among Spanish music conservatory students; the neck and shoulders and the upper back proved to be the most common sites of pain.[23]

A Dutch study mentioned that in one year, 80.7% of music students had PRMD, showing that this population highly suffers from musculoskeletal complaints.[21] In other studies, the prevalence remained high, showing that the population suffering from PRMD is always an important factor in music students all over the world. Several risk factors have been identified that seem to be consistently and strongly associated with PRMD development among music students. The most-often-reported risk factors involve practice duration and practice intensity. Many studies have cited that long practice without adequate rest is highly associated with the development of PRMD.

3.2. Gender, psychological, physiological, and professional factors

Several factors have been consistently found to be strongly associated with the emergence of PRMD in music students. Practice duration and intensity are the most commonly reported risk factors. Studies have emphasized that prolonged practice without proper rest is strongly associated with the development of PRMD. Specifically, Cruder reported that students who practiced more than four hours per day were at significantly higher risk for musculoskeletal symptoms,[33] this is also verified by the study from Portugal.[24]

There are also differences among genders where female music students have a higher prevalence of PRMD as compared to the males.[20,21,23,25] For example, the results of one study conducted among students at the Portuguese Conservatory of Music indicated that female respondents were more likely to suffer neck and shoulder pain, this aligns with existing literature, as female musicians are indeed more prone to musculoskeletal problems compared to their male counterparts due to combined anatomical, physiological, and psychosocial factors such as heightened stress perception.[26] Other researches from Europe have also concluded the same, as well as in Malaysia, by noting that PRMD is more incident in female students than their male counterparts.[25]

On the other hand, several studies have shown that students who participate in regular physical activity outside of music practice are less likely to report musculoskeletal complaints. Conversely, those students who lacked physical activity were at higher risk.[24]

As shown in Laura and Steinmetz's study,[5,21] the type of musical instrument is another key factor influencing the incidence of PRMD, with stringed instrument players and piano players being particularly affected by the need to use asymmetrical postures when completing repetitive movements with these instruments, which can place constant stress on specific muscle groups. Reports indicate that they have a relatively high incidence of musculoskeletal problems in areas such as the neck, shoulders and upper limbs. Woodwind players demonstrate a similar risk, with an increased probability of problems in their right hand and wrist, further demonstrating a direct relationship between how an instrument is played and PRMD.[21,27]

3.3. Affected Anatomical Regions

In the music student population, the neck, shoulder, lower back, and upper extremities are the anatomical areas most frequently affected by PRMD. According to relevant reports, among Malaysian classical piano students, the shoulder was the most frequently affected part of the body, followed by the arm and hand.[25] Another study found that woodwind and string instrument players had a higher prevalence of upper extremity and neck pain, which was mainly due to the asymmetrical posture used in playing the instrument. Additionally, studies of orchestra and conservatory students have highlighted that the repetitive movements inherent in music practice and static postures maintained for long periods of time further exacerbate the severity of these musculoskeletal disorders.[23]

3.4. Self-management preference

Most of the students tend to use self-management strategies instead of seeking professional medical services when experiencing the symptoms.[28] Other self-management strategies used by the students are practice procedures modification, taking appropriate breaks, and use of over-the-counter painkillers.[24,28]

4. Discussion

This systematic review, based on 11 cross-sectional studies in diverse geographical and educational settings, aims to assess the prevalence, related factors, and impacts of PRMD among music majors. The included studies offer diverse insights into PRMD's prevalence, risk factors, and methodological challenges in surveying this population, which are of significant value for in-depth exploration and can provide a solid theoretical basis for further research and intervention formulation.

4.1. Heterogeneity in methodology and the importance of validated measurement tools

The methods used in these studies show considerable heterogeneity, particularly in terms of research design, sample size and choice of measurement tools. Some of the studies reviewed used validated tools, such as the PPAM, NMQ, DASH and NDI, which largely contribute to ensuring consistency in the assessment of musculoskeletal complaints.[23,24] However, it should be noted that some studies employed self-designed questionnaires that had not been validated for validity or reliability, which inevitably raises concerns about measurement bias and the accuracy of the reported prevalence.[5] In fact, the use of standardised and validated measurement tools when conducting relevant studies, especially cross-sectional studies on populations with different cultural and educational backgrounds, is a crucial step to ensure the reliability of research findings.[25] This is not only related to the scientific and rigorous nature of the research itself, but also has a significant impact on subsequent analyses, decisions and further research based on the results, and should therefore be highly emphasized.

4.2. Limitations of response rates and study design in PRMD research

In related studies, response rates for PRMD have been found to vary significantly between student populations. Some of these studies had response rates below the commonly accepted threshold of 70%, and this low response rate limits the reliability and representativeness of the findings.[19,21,25] These differences in rates highlight the importance of robust design and expose non-response bias, which affects the final interpretation of the results.

The reasons for low response rates are complex. In the case of the PRMD survey for the student population, respondents had to overcome a number of difficulties in order to complete the survey. On the one hand, students, especially music students, are under great academic pressure.[29] Not only do they have to complete theoretical and general courses, but they also have to ensure hours of professional practice every day, which naturally puts music students at a disadvantage compared to other groups when completing the survey.[30,31]

On the other hand, music students are deeply concerned about their future career development. Unlike students of other subjects, most music students will continue to be involved in music performance-related work in the future, making them vulnerable to concerns about data leakage. Both the fear of exposure of their own health data and the lack of trust in the researcher and the research project will reduce their willingness to complete the questionnaire.

From a research design perspective, response rates were significantly lower for questionnaires longer than 20 minutes, especially in surveys that lacked incentives.[32] This situation can lead to a perceived imbalance between effort and benefit, which may result in non-response or invalid results.

4.3. Inconsistent PRMD definitions and overlooked confounding factors

As research has progressed, we have noticed an increasing tendency to use a standard definition of musicians' muscular complaints arising from performance and related activities, also known as PRMD. This definitional approach, derived from working-related musculoskeletal disorders, has the advantage of delimiting the scope of most studies, so that most research can be conducted within the definition of work-related muscular complaints and musculoskeletal problems. The methodology has its advantages. However, it also has the disadvantage of ignoring some conditions of pain and discomfort that are potentially related to performance activities but are not included in the well-defined considerations of PRMD.

4.4. Validated tools and diverse samples in PRMD research

The discussions highlight the importance of using validated measurement tools in cross-sectional studies to accurately capture the prevalence of PRMD and associated risk factors. Future research should priorities the inclusion of larger and more diverse samples and the use of standardised and reliable instruments to strengthen the evidence base for preventive interventions for this vulnerable group of music students.[33]

4.5. Cultural differences in research tools for studying PRMD

The research tools used by scholars in studying musculoskeletal problems among music students vary greatly from country to country. In Malaysia, past studies have focused on collecting information on the basic living and playing habits of music students as well as the performance of basic injuries, so these studies usually used purposeful self-report survey instruments specifically designed for a single study. This phenomenon may be due to the late start of PRMD research in these geographical areas and the lack of accumulation of relevant research, resulting in the need to construct studies from a more initial perspective.[19,25] In contrast, relying on a more comprehensive music education system and survey experience, European studies have typically used more in-depth structured questionnaires to collect more detailed

information on health and playing habits beyond basic information, while a large number of structured questionnaires validated in different linguistic contexts and with different survey purposes have been used, e.g. the KMPAI questionnaire to investigate students' performance anxiety, the BPI questionnaire to investigate the daily pain index, etc.[20,24]

5. Conclusion

This study systematically and comprehensively investigated the prevalence and main risk factors of PRMD among music students in higher education, as well as the potential flaws and deficiencies of cross-sectional studies. Studies have shown that this particular group of student musicians faces a high occupational health risk. In view of this, researchers from more different cultures and regions should be encouraged to carry out relevant research in the future, and use validated and reasonable combination of comprehensive survey tools to reveal the PRMD status of music students in different genders, ages, regions, cultures, performance styles, and living habits, as well as in more specialized fields. Through the collaboration of researchers and educators in multiple fields, comprehensive occupational health protection and scientific learning planning programs are provided for this group.

6. Limitation

This review only covered the selected databases, which may have resulted in the exclusion of other studies that met conditions of this study. Furthermore, the study was restricted to adult professional music students; due to which relatively few studies met the eligibility criteria and couldn't be further compared and analyzed. Other limitations that are important include the fact that the given study did not look into the systems of music education applied by the various countries concerned. This is so because such educational programmes involve cultures, educational practices, and educational levels of the different countries; different educational strategies and programmes would make comparisons unfair.

7. Recommendations for future research

This study review therefore suggests that future cross-sectional studies follow a more rigorous research design. Researchers must design studies with due attention to all aspects of the study in terms of the accurate selection of participants, distribution of survey instruments, and collection process; similarly, in choosing software for data analysis. A more comprehensive approach is deemed necessary to overcome the drawbacks of previous research; and such research also calls for the highest possible sampling size.

There is a need for uniform definitions of PRMD and appropriate methods of outcome measurement. That way, comparisons among different studies will be easier; it would facilitate meta-analyses. This consistency in definitions and measures will allow research into the complex nature of PRMD in this population by adding from other studies.

It is further relevant to extend the scope of research towards music students from other cultural and regional backgrounds. Keeping in view the use of traditional instruments and performance practices related to Chinese, Indian, or other musical traditions, one will be better informed about how various musical cultures might influence the development of PRMD. The results will, in turn, contribute to the articulation of more context-specific and effective preventive and management strategies for PRMD among music students around the world.

In particular, the general quality of research in this area needs to be continually improved by overcoming methodological limitations, regularly reviewing the available research and encouraging

researchers to collaborate. In this regard, future studies are warranted to provide useful evidence to add to the knowledge base that will ultimately lead to improved health and performance conditions for music students.

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Conflict of interest

The authors declare no conflict of interest.

References

1. Mariyam Farzana S. Effect of Finger and Hand Exercises among Amateur Pianist. Indian Journal of Forensic Medicine & Toxicology. 2021;15(1).
2. Altenmüller E, Kopiez R. Suffering for her art: the chronic pain syndrome of pianist Clara Wieck-Schumann. Neurological Disorders in Famous Artists-Part 3. 27: Karger Publishers; 2010. p. 101-18.
3. Truelove C. The Evolution of Solo Violin Performers In Film Music History: Syracuse University; 2017.
4. Khalsa S, Butzer B, Shorter SM, Reinhardt KM, Cope S. Yoga reduces performance anxiety in adolescent musicians. Alternative Therapies in Health and Medicine. 2013;19(2):34-45.
5. Steinmetz A, Möller H, Seidel W, Rigotti T. Playing-related musculoskeletal disorders in music students-associated musculoskeletal signs. Eur J Phys Rehabil Med. 2012;48(4):625-33.
6. STRENÁČIKOVÁ M. HEALTH PROBLEMS OF PROFESSIONAL MUSICIANS AND MUSIC STUDENTS. University Review (1337-6047). 2020;14(3).
7. Kenny D, Ackermann B. Performance-related musculoskeletal pain, depression and music performance anxiety in professional orchestral musicians: a population study. Psychology of Music. 2015;43(1):43-60.
8. Austen C. 'I'm not injured, this is just my life': an exploration of the experiences of conservatoire students with chronic playing-related musculoskeletal disorders: Royal College of Music; 2020.
9. Wang X, Cheng Z. Cross-sectional studies: strengths, weaknesses, and recommendations. Chest. 2020;158(1):S65-S71.
10. Haug U, Riedel O, Cholmakow-Bodechtel C, Olsson L. First-degree relatives of cancer patients: a target group for primary prevention? A cross-sectional study. British journal of cancer. 2018;118(9):1255-61.
11. Adorno M, Garbee D, Marix ML. Improving literature searches. Clinical Nurse Specialist. 2016;30(2):74-80.
12. Tate RL, Douglas J. Use of reporting guidelines in scientific writing: PRISMA, CONSORT, STROBE, STARD and other resources. Brain Impairment. 2011;12(1):1-21.
13. Baadjou VA, Roussel NA, Verbunt J, Smeets R, de Bie R. Systematic review: risk factors for musculoskeletal disorders in musicians. Occupational Medicine. 2016;66(8):614-22.
14. Shea BJ, Hamel C, Wells GA, Bouter LM, Kristjansson E, Grimshaw J, et al. AMSTAR is a reliable and valid measurement tool to assess the methodological quality of systematic reviews. Journal of clinical epidemiology. 2009;62(10):1013-20.
15. Kochem FB, Silva JG. Prevalence of playing-related musculoskeletal disorders in string players: a systematic review. Journal of manipulative and physiological therapeutics. 2018;41(6):540-9.
16. Loney PL, Chambers LW, Bennett KJ, Roberts JG, Stratford PW. Critical appraisal of the health research literature: prevalence or incidence of a health problem. Chronic Dis Can. 1998;19(4):170-6.
17. Kok LM, Huisstede BM, Voorn VM, Schoones JW, Nelissen RG. The occurrence of musculoskeletal complaints among professional musicians: a systematic review. International archives of occupational and environmental health. 2016;89:373-96.
18. Kitsiou S, Pare G, Jaana M. Systematic reviews and meta-analyses of home telemonitoring interventions for patients with chronic diseases: a critical assessment of their methodological quality. Journal of Medical Internet Research. 2013;15(7):e2770.

19. Lonsdale K, Boon OK. Playing-related health problems among instrumental music students at a university in Malaysia. Medical problems of performing artists. 2016;31(3):151-9.
20. Árnason K, Árnason Á, Briem K. Playing-related musculoskeletal disorders among icelandic music students: differences between students playing classical vs rhythmic music. Medical Problems of Performing Artists. 2014;29(2):74-9.
21. Kok LM, Nelissen RG, Huisstede B. Prevalence and consequences of arm, neck, and/or shoulder complaints among music academy students: a comparative study. Medical problems of performing artists. 2015;30(3):163-8.
22. Kirkham JJ, Altman DG, Chan A-W, Gamble C, Dwan KM, Williamson PR. Outcome reporting bias in trials: a methodological approach for assessment and adjustment in systematic reviews. bmj. 2018;362.
23. Rodríguez-Romero B, Pérez-Valiño C, Ageitos-Alonso B, Pértega-Díaz S. Prevalence and associated factors for musculoskeletal pain and disability among Spanish music conservatory students. Medical Problems of Performing Artists. 2016;31(4):193-200.
24. Zão A, Altenmüller E, Azevedo L. Factors Associated with Performance-Related Pain Among Musicians: A Multicenter Study Using Validated Tools. Journal of Occupational Rehabilitation. 2024:1-22.
25. Ling C-Y, Loo F-C, Hamedon TR. Playing-related musculoskeletal disorders among classical piano students at tertiary institutions in Malaysia: proportion and associated risk factors. Medical problems of performing artists. 2018;33(2):82-9.
26. Z'Graggen S, Ettlin DA, Alessandri E, Z'Graggen WJ, Schimmel M. Prevalence of Painful Temporomandibular Disorder Symptoms Among Professional and Student Musicians: An Online Survey. Journal of Oral Rehabilitation. 2024.
27. Steinmetz A, Seidel W, Muche B. Impairment of postural stabilization systems in musicians with playing-related musculoskeletal disorders. Journal of manipulative and physiological therapeutics. 2010;33(8):603-11.
28. Stanek JL, Komes KD, Murdock FA. A cross-sectional study of pain among US college music students and faculty. Medical Problems of Performing Artists. 2017;32(1):20-6.
29. Sternbach DJ. Stress in the lives of music students. Music educators journal. 2008;94(3):42-8.
30. Kostka MJ. Practice expectations and attitudes: A survey of college-level music teachers and students. Journal of Research in Music Education. 2002;50(2):145-54.
31. Miksza P. The development of a measure of self-regulated practice behavior for beginning and intermediate instrumental music students. Journal of Research in Music Education. 2012;59(4):321-38.
32. Guo Y, Kopec JA, Cibere J, Li LC, Goldsmith CH. Population survey features and response rates: a randomized experiment. American journal of public health. 2016;106(8):1422-6.
33. Cruder C, Barbero M, Koufaki P, Soldini E, Gleeson N. Prevalence and associated factors of playing-related musculoskeletal disorders among music students in Europe. Baseline findings from the Risk of Music Students (RISMUS) longitudinal multicentre study. PloS one. 2020;15(12):e0242660.

Reference	Participants (music students)	Instrument groups included	Prevalence	Measures	Location	Outcomes	Score
Zão et al., 2024	Total: 294 Female: 153 Male: 137 Response Rate: 82.4%	String Woodwind Brass Keyboard Percussion Singers Conductors	Overall: 42.5% By Gender: Male: 35.8% Female: 54.9%	PPAM MFIS K10 FMPS-B SF-36 IPAQ	Portugal	Among music major students, the incidence of Performance - Related Pain (PRP) is 42.5%. Although lower than that of professionals, these students have significantly higher anxiety and fatigue levels and a decline in quality of life, all being crucial PRP risk factors.	8
Z'Graggen et al., 2024	Total: 95 Male: 28 Female: 66 Response Rate: Unknown	Low bow High bow Singer Organ Keyboards W& B wind	Overall: 28%	TMD	Switzerland Austria Germany	Young, inexperienced female musicians, particularly keyboard and upper string players, exhibit a heightened risk of TMD, indicating a specific vulnerability within this demographic.	6
Ling et al., 2018	Total: 192 Female: 163 Male: 29 Response rate: 61.7%	Classical piano	Overall: 35.8% By Gender: Female: 34.4% Male: 41.4%	Custom-designed questionnaire	Malaysia	Significant associations between PRMD occurrence and inadequate practice habits, including lack of breaks, cool-down exercises, and special dietary intake, underscore the need for awareness and preventive measures. Emphasizing improved practice routines and physical conditioning is crucial for sustaining a long-lasting music career among classical piano students.	6
Steinmetz et al., 2010	Total: 36 Females: 24 Males: 12 Response Rate: 100%	Piano Violin Violoncello Double Bass Trumpe Flute French Horn Oboe Accordion Bassoon Clarinet Trombone Harp Recorder Voice	Overall: 81.3%	Custom-designed questionnaire SF-12	Germany	Music students reported an average of 6.19 pain locations and showed higher prevalence of musculoskeletal dysfunctions, including decreased neck flexor force and tight shoulder rotators, compared to non-music students. These findings highlight the critical need for preventive strategies to address musculoskeletal health and PRMD among this population.	7

Reference	Participants (music students)	Instrument groups included	Prevalence	Measures	Location	Outcomes	Score
Rodríguez-Romero et al., 2016	Total: 145 Female: 89 Male: 56 Response Rate: Unknown	String instruments Woodwind Brass Percussion Singing Other winds	Higher prevalence among females	NMQ-E VAS NDI DASH SF-36	Spain	Musculoskeletal pain (MSP) is highly prevalent among Spanish music conservatory students, mainly affecting the neck, upper back, and shoulders, with slight to moderate disability. Gender differences and links to physical activity and mental health emphasize MSP as a significant issue in this group.	6
Ballenberger et al., 2023	Total: 146 Female: 69 Male: 77 Response Rate: 66%	Not described in detail	Overall: 17%	K-MPAI SF-12 HADS SCI FMPS-D Beighton Score	Germany	Music students exhibit higher rates of musculoskeletal complaints compared to peers in other disciplines, with increased pain and reduced physical functioning, particularly among those with current or past musculoskeletal health conditions. Freshmen are at heightened risk, especially those with pre-existing physical health issues.	6
Lonsdale & Boon, 2016	Total: 55 Male: 43 Response Rate: 25.7%	Piano Flute Oboe Clarinet Saxophone Trumpet French hom Trombone Euphonium Violin Viola Cello Double bass Classical guitar Electric guitar Electric bass Electric keyboard Drum set/kit Timpani Percussion Gambus Malay drums	Overall: 28.9%	Self-reported online survey	Malaysia	Malaysian music students experience significant PRMD, including pain in fingers, hands, neck, and shoulders, with 36.8% reporting impacts on practice duration. Comparable to international rates, these findings highlight the need for improved injury prevention education to support student health and careers.	5
Árnason et al., 2014	Total: 74 Female: 32 Male: 42 Response Rate: Unknown	Strings Woodwind/Brass Piano Vocal Percussion	Overall: 62%	Custom-designed questionnaire	Iceland	Classical music students exhibit a higher PRMD prevalence (69.9%) compared to rhythmic students (38.9%), with greater impacts observed among female students. These findings underscore the need for improved health promotion and preventive education in music schools.	5

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Reference	Participants (music students)	Instrument groups included	Prevalence	Measures	Location	Outcomes	Score
Cruder et al., 2020	Total: 850 Female: 522 Male: 325 Other: 3 Response Rate: 90.3%	Accordion Bowed Plucked Woodwind Brass Percussion Singers Keyboard	Overall: 48%	IPAQ K10 Multidimensional Perfectionism Scale Chalder Fatigue Scale Self-Rated Health, and bespoke questions regarding practice habits and health history	European countries Austria / Belgium / Denmark / Estonia / Finland / France / Germany / Iceland / Ireland / Italy / Latvia / Portugal / Scotland (UK) / Spain / Sweden / Switzerland / The Netherlands	PRMD is highly prevalent among European music students, particularly those from Western Europe, at advanced academic levels, with extensive practice experience, and reporting higher perceived exertion after prolonged practice without breaks. These findings highlight the need for targeted prevention and treatment strategies.	6
Kok et al., 2015	Total: 83 Female: 62 Male: 21 Response Rate: 25%	Classical instrument (Singers & conductors excluded)	12-month: 80.7% Point: 47.0% Chronic: 36.1% By Gender: Females: 84% Males: 71%	Custom-designed questionnaire	Netherlands	Music academy students show a higher prevalence of chronic musculoskeletal complaints (CANS) and greater daily functional impairment compared to medical students, with symptoms affecting multiple anatomical sites, including pain and motor issues. These findings underscore the need for targeted preventive interventions in this population.	5
Stanek, et al., 2017	Total: 800 Female: 489 Male: 311 Response Rate: Unknown	Voice Woodwinds Brass Bowed strings Guitar & Harp Percussion Keyboard	Overall: 66.6%	Custom-designed questionnaire	United States	This study identified a high prevalence of performance-related pain (PRP) among U.S. college music students and faculty, with 67% of respondents reporting symptoms. The highest prevalence was observed in woodwind musicians (83%) and bowed string players (80%), with the upper back (27%) and lower back (26%) being the most frequently affected anatomical regions. Female participants exhibited consistently higher PRP rates across all roles. Alarmingly, less than 25% of those affected sought medical assistance	5

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