Article

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Explore pain perception and pain self-efficacy in acrobats in the context of holistic management: a scoping review.

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Abstract
Background: Within the acrobatic community, there is a strong belief that pain, defined as "an unpleasant sensory and emotional experience associated with; or resembling that associated with actual or potential tissue damage", is normal when training and performing. Acrobats are subject to extraordinary physical and psychological demands, sometimes leading to pain and injury, which has an impact on their performance and well-being.
Objective: This research aimed to explore the physical and psychological factors that influence pain perception and pain self-efficacy and identify best practices which will inform pain management in acrobats. This research will be useful to summarise the existing literature evidence in this area which could inform future research projects around holistic pain management.
Design: A literature search of ProQuest and Web of Science databases was undertaken for the period between 2012 to 2023, using the search terms "pain", "pain perception" and "self-efficacy" in those who practised the following acrobatic disciplines: circus performers, gymnasts, and cheerleaders.
Results: 28 studies were identified to form the key findings of this review. This research found that pain in acrobats could be identified as either injury-related or performance-related. Risk factors for pain included internal, external, and psychological factors. Some acrobats believe in "no pain, no gain," which implies a high self-efficacy, that is the ability to continue training despite the pain. The findings suggest that a holistic pain management approach, involving multiple stakeholders, may incorporate the following components: 1) maintaining a healthy physical condition, 2) reviewing training load, 3) managing stress, 4) differentiating pain, and 5) sharing available resources. A positive relationship with coaches and teachers is key in the early identification and treatment of pain.
Conclusion: In conclusion, this scoping review offered insight into pain behaviours and explored best practices around holistic pain management in acrobats. To manage pain, it is recommended to address the following: general health, training loads, stress, pain self-identification and signpost to resources. These strategies could help reduce pain incidents and promote career longevity.

Keywords
Acrobat, Gymnast, Circus Performers, Pain, Injury, Pain perception, Self-efficacy

Introduction

The term "acrobatic sports" encompasses exercises and adapted skills from gymnastics that include various body positions on and off the ground [1]. These include tumbling, jumping and stunting. In this research, we will define the individuals who undertake circus arts as acrobatic performers, gymnasts, and cheerleaders as 'acrobats' [1–4]. The dynamic movements vary in degree of difficulty and can include high-impact activities [5], they require extraordinary physical demands that can result in pain and injury [6–9]. Consequences of an injury or accumulation of injuries may result in retirement [10].

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Acrobats commonly face musculoskeletal (MSK) pain due to the physical demands of their activities. Injuries resulting in pain are common in gymnasts [11] and circ us performers [12]. Given the unique physicality of acrobats, more research is needed on this topic.

Pain is a complex and multifactorial phenomenon [13], an individual's pain experience can be influenced by biopsychosocial factors such as their health conditions, beliefs, and environment. Pain can lead to physical discomfort and the need for medical attention in acrobats [11,12]. According to Bunman et al. [14], university athletes' pain behaviours are associated with their health-related beliefs and the pressure they put on themselves. Bumann et al. [14] identified a positive relationship between pain intensity and psychosocial factors such as depression, anxiety, and

stress in university athletes. They found that physical pain limited the athlete's mental health, and often co-occurred with fatigue (80%) and sleep disorders (60%). In gymnasts, there is often an expectation that pain is part of participating and being successful in their sport; "no pain no gain" and "pushing through pain" are common beliefs [10]. This belief is also seen in aerial performers as they perceive pain as being required for them to progress with their training [15]. Therefore, it is essential to consider the psychological risk factors when managing pain.

Self-efficacy is a psychosocial factor referring to a person's belief in their ability to deal with a specific task and low self-efficacy is thought to be an obstacle to pain recovery [16]. Tynan and MacEvilly [10] found that elite gymnasts perceived pain as either good "performance" and/or bad "injury" pain. Ghazaie et al. [17] explored the relationship between pain perception and self-efficacy in female athletes and discovered that they had a low pain perception and a high self-efficacy, meaning they were able to endure more pain. This is an important area to address as Faltus and Richard [18] highlighted that circus performers with low self-efficacy, are twice more likely to sustain an injury and have higher anxiety. Therefore, this research aims to review the physical and psychological factors that influence pain in acrobatic performers and athletes and identify best practices which will inform pain management in acrobats.

Methods

Research aims

1. To explore the current literature regarding pain perception and pain self-efficacy beliefs that could affect acrobats.
2. To identify best practices which will inform pain management in acrobats.

It is hypothesised that pain awareness and one's perception of it influence self-efficacy and the ability to self-manage pain.

Search strategy

To identify relevant studies, Web of Science and ProQuest database searches were performed between November 2012 to November 2023. Search terms included "pain" OR "chronic pain" AND "self-efficacy" OR "beliefs" OR "perception" AND "acrobat" OR "performer" OR "gymnast" OR "cheerleader" OR "athlete" in combination. After applying the inclusion and exclusion criteria, a total of 28 papers were identified for this study. Broad search terms were chosen to capture the scope of the literature and thus not restricted to the title alone. The library of references was transferred to Mendeley Cite to identify duplication and screen papers. Any duplications were removed to avoid double reporting.

Inclusion and exclusion criteria

All databases searched were web-based and included qualitative and quantitative studies. The search was limited to the last 11 years (2012 to 2023) and only included full-text and peer-reviewed articles that described pain. Studies that were non-English articles or abstracts without full access to text or that described other "acrobatic sports" that do not fall in line with the definition in this paper were excluded from this study.

When constructing the search, the title and abstracts were screened. The PICO framework (Population, Intervention, Comparison and Outcome) was used to ensure a comprehensive search[19] and selected papers were populated following the structure laid out in Table 1.

Results

Table 2 illustrates the breakdown of the search terms and the number of papers found in each database. Table 3 outlines an overview of the search limiters applied (inclusion and exclusion criteria).

The results below present the results from the database search. All terms marked with a * are a truncation to help find different word endings. For example, acrobat* searches for acrobat, acrobats, acrobatic and acrobatics.

Study selection and screening process

All methodology including the search, data collection and inclusion/exclusion of papers were performed by the same researcher. The initial search yielded 48 studies. After applying search limiters, a total of 28 papers were identified for review. Duplicate references were identified and removed using Mendeley cite to avoid double reporting. A PRISMA flowchart, as shown in Figure 1, illustrate the study selection process, from initial identification, screening to final inclusion, for this scoping review.

Amongst the 28 studies, there were varied methodological approaches, including 6 observational studies [2,20–24], 5 cross-sectional studies [14,25–28], 4 prospective cohort studies [5,9,12,29], 3 systematic

reviews [6,30,31], 2 qualitative studies [10,32], 2 pilot studies [33,34], 1 clinical trial [35], 1 retrospective cohort [1], 1 literature review[3], 1 retrospective analysis [8], 1 descriptive epidemiology study [36], and 1 clinical commentary [18]. Most of the studies appeared to focus on adult circus performers [4–6,9,12,15,18,21,23,26,32,34] and gymnasts [1,7,8,10,11,20,24,30,37,38].

One study included adolescent rhythmic gymnasts [29]. Gender distribution was not explicitly reported in all studies. After further reviewing these papers, key themes were identified.

Table 1: Result template from the search terms

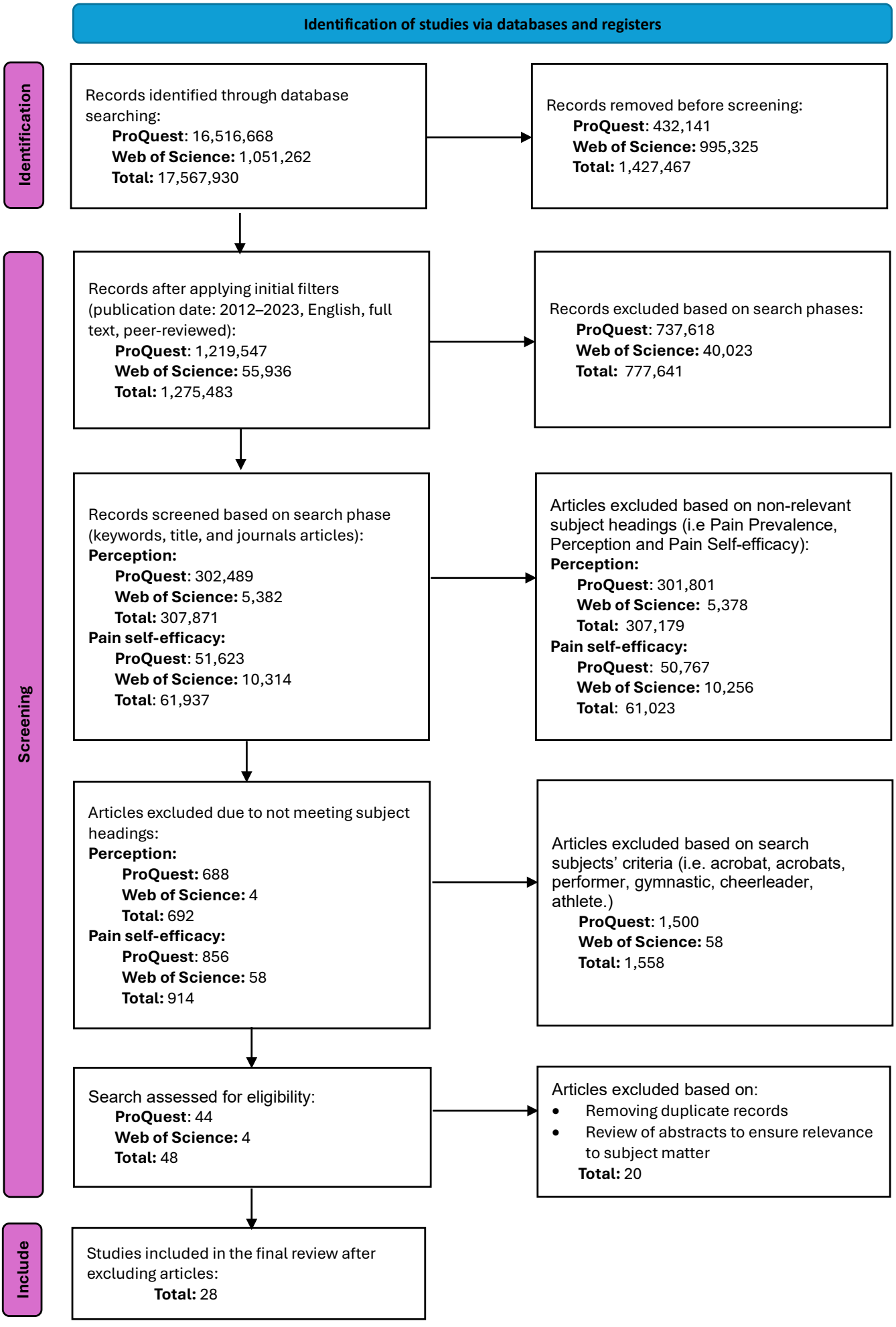
Title Authors Year	Description of study (PICO) Aims / Participants/ Outcomes	Key Questions to reflect on Plans for writing a scoping review	Categories / Themes / Notes (Pain prevalence / Related factors / Source of pain / Impact of pain / Pain self-efficacy / Pain management / Pain response) 1 General, 2 Related, 3 Very relevant

Table 2: Search terms and results from databases.

Search terms	*ProQuest*	*Web of Science*
Pain	1,219,547 results	55,936 results
Pain prevalence	302,489 results	5,382 results
Pain prevalence AND acrobat* OR performer*	127,817results	217 results
Pain prevalence pain AND gymnast* OR cheerlead* OR Acrobat*	22,410 results	65 results
Perception AND pain AND performer* OR circus	11,413 results	1,924 results
Perception AND pain AND performer* OR Acrobat*	3,019 results	46 results
Perception AND pain AND performer* AND gymnast* OR cheerlead* AND Athlete*	688 results	4 results
Pain self-efficacy and acrobat* or performer	51,623 results	10,314 results
Pain self-efficacy AND acrobat* OR performer AND injury	4,371 results	189 results
Pain self-efficacy AND acrobat* OR performer	63,555 results	10,314 results
Pain self-efficacy AND gymnast* OR cheerlead* AND Athlete*	856 results	58 results

Table 3: An overview of the search limiters

Search limiters
Publication date: Last 11 years (2012-2023)
Limited to: Full text, English language, and peer-reviewed
Search phase: keywords, title, and journals articles
Subject headings: Pain, Chronic Pain, Injuries


Identification of studies via databases and registers
Identification
Records identified through database searching:
ProQuest: 16,516,668
Web of Science: 1,051,262
Total: 17,567,930
Records removed before screening:
ProQuest: 432,141
Web of Science: 995,325
Total: 1,427,467
Screening
Records after applying initial filters (publication date: 2012–2023, English, full text, peer-reviewed):
ProQuest: 1,219,547
Web of Science: 55,936
Total: 1,275,483
Records excluded based on search phases:
ProQuest: 737,618
Web of Science: 40,023
Total: 777,641
Records screened based on search phase (keywords, title, and journals articles):
Perception:
ProQuest: 302,489
Web of Science: 5,382
Total: 307,871
Pain self-efficacy:
ProQuest: 51,623
Web of Science: 10,314
Total: 61,937
Articles excluded based on non-relevant subject headings (i.e Pain Prevalence, Perception and Pain Self-efficacy):
Perception:
ProQuest: 301,801
Web of Science: 5,378
Total: 307,179
Pain self-efficacy:
ProQuest: 50,767
Web of Science: 10,256
Total: 61,023
Articles excluded due to not meeting subject headings:
Perception:
ProQuest: 688
Web of Science: 4
Total: 692
Pain self-efficacy:
ProQuest: 856
Web of Science: 58
Total: 914
Articles excluded based on search subjects' criteria (i.e. acrobat, acrobats, performer, gymnastic, cheerleader, athlete.)
ProQuest: 1,500
Web of Science: 58
Total: 1,558
Search assessed for eligibility:
ProQuest: 44
Web of Science: 4
Total: 48
Articles excluded based on:
Removing duplicate records
Review of abstracts to ensure relevance to subject matter
Total: 20
Include
Studies included in the final review after excluding articles:
Total: 28

Discussion

Pain can lead to physical discomfort and the need for medical attention in acrobats [11,12]. The following discussion explores acrobats' perception of pain and how it may influence their pain self-efficacy.

Pain perception and incidence

Studies examining injury incidence amongst acrobats reveal a high prevalence of injuries, with rates ranging from 1.5 to 9.7 injuries per 1000 athletic exposures in gymnasts [30] and 7.37 to 9.7 injuries per 1000 artist exposures in professional circus artists [6]. A summary of the injury incidents is shown in **Table 4.** The commonly injured body location includes the head [20] and ankles [24,29] in gymnast acrobats. Whereas in circus acrobats, the shoulder (27.7%) [34], lower back (15.8%) and wrist (14.1%) were the most reported injuries [12].

Within circus injuries, floor acrobatics accounted for the majority (50%) of the injuries during training, and the skills involved included acrobatics, tumbling and handstands [6]. In terms of type of discipline, ground acrobatics has the highest associated injury (53.2%), [34] followed by aerial acrobatics (38.3.3%). Overuse injuries, particularly amongst wheel gymnasts [20] and rhythmic gymnasts [29], contribute significantly to pain experiences in acrobats.

Factors that may influence pain perception

To differentiate pain perception, acrobats categorised their pain as either good "performance pain" or bad "injury pain" [10,32]. Internal factors such as being taller [30], older [8] and heavier (higher body mass) were correlated with a greater risk of gymnastic injuries [29].

Additionally, external factors such as training duration and intensity were shown to contribute to the prevalence of MSK pain, with longer and more frequent training sessions associated with increased pain incidence in acrobatic athletes [1,7,22,24,29].

The training schedule can influence injury rate, and having 2 rest days every 4-6 weeks was shown to help reduce injury risk in acrobats [2]. However, there are limitations in assessing the benefits of rest days as it is difficult to differentiate between the pain resulting from a new and an old injury in acrobats, as well as determining the "injury date" for an overuse injury.

Psychosocial factors, particularly stress, were also shown to play a major influence on pain occurrence and pain intensity [14]. It has been reported that circus acrobats commonly experience stress [26]. Within the acrobatic context, stress may originate from organisations, competitions, and personal lives [7,26]. Many acrobats normalise pain as part of their training regimen, viewing it as a sign of success and achievement [10,15,38]. Participants in Tynan et al, research described their "conditioning pain" as a "good" pain that will lead to "improvement", and reported a perception that accepting such pain as "a daily thing" would make them stronger [10]. Coaches often play a critical role in shaping athletes' attitudes towards pain [10,11]. Interestingly, as athletes get older, they commonly demonstrate greater autonomy in managing their pain compared to younger athletes [10,11].

Pain self-efficacy

Pain beliefs play a crucial role in understanding pain self-efficacy amongst acrobats [16]. Studies have shown that higher levels of pain self-efficacy are associated with lower pain intensity and disability in individuals with chronic MSK pain [25] . In circus acrobats, pain self-efficacy has been identified as a significant predictor of injury risk and low self-efficacy has been associated with twice the risk of injury [23]. Despite experiencing pain, acrobats [14,15] often continue to perform and train, suggesting high levels of self-efficacy and resilience [39]. This willingness to "push into pain" may be influenced by the "no pain, no gain" belief [10]. In acrobatic performers, aerialists have been reported to often train despite pain [15]. In an interview carried out by Cayrol et al., the findings suggested that the relationship between injury and coping with pain may partly be explained by the pressure around employment, financial needs, and perfectionism [10,32]. Together, these studies indicate that pain self-efficacy is potentially high amongst acrobats, and a common coping mechanism is to adapt and perform despite the pain.

Pain management best practices

Pain management can be challenging and less experienced acrobats who lack self-awareness may "push into pain" and exacerbate it, which can lead to injury [10,40]. A multidisciplinary approach should be considered in pain and injury management [31]. Firstly, coaches are crucial in the training and management of pain in acrobats [10,11]. Good coaches can support the

early identification of pain and facilitate the rehabilitation process.

Secondly, injury prevention is crucial as it can reduce the risk of injuries and pain [31,32]. Injury risk amongst acrobats may be reduced through educational programs for pain prevention within organisations [14].

Thirdly, health screening and physical examination by health professionals, such as a physiotherapist, can lower the risk of MSK injury if not pain [8]. When working with acrobats, their discipline and related physical demands should inform their risk assessment [24]. Acrobatic discipline varies in skills difficulties, the use of apparatus, the number of participants and the nature of performance (sports versus art form) and these factors may lead to different sources of pain.

Finally, the availability of professional produced online pain management resources, and the regulation of the acrobatic industry, may improve access and the quality of pain management interventions available to acrobats [32]. **Table 5** includes a list of recommendations for practitioners to follow when managing pain in acrobats

Conclusions

In conclusion, this scoping review offered insight into pain behaviours and explored best practices around holistic pain management in acrobats.

The first aim of this review was to explore pain perception and pain self-efficacy beliefs amongst acrobats. Acrobats are subject to extraordinary physical and psychological demands, and there is a high incident of injuries ranging from 1.5 to 9.7 injuries per 1000 athletic exposures in gymnasts and 7.37 to 9.7 injuries per 1000 artist exposures in professional circus artists. It has been suggested that implementing rest days within the training schedule can help reduce the injury risk in acrobats.

The findings on pain beliefs provided a deeper insight into how acrobats tend to cope with pain. Pain is seen as common and often gets categorised as either good "performance pain" or bad "injury pain". Older acrobats seem to be able to better differentiate between the two. These pain behaviours potentially suggest high levels of pain self-efficacy amongst acrobats. Perhaps, challenging the belief of "no pain, no gain", and learning the balance between rest and training can help reduce the risk of injuries.

Lastly, this review aimed to identify best practices and inform pain management strategies. Practitioners working with acrobats should consider the physical and psychological demands of their discipline in their return to performance plan. The findings suggest that a holistic pain management approach, involving multiple stakeholders, may incorporate the following components: general health, training loads, stress, pain self-identification and sign posting resources. These strategies could help reduce pain incidents and promote career longevity.

Limitations and Future Research Direction

While this study provides valuable insights into pain perception and self-efficacy amongst acrobats, several limitations must be acknowledged. The lack of gender diversity in existing research underscores the need for more inclusive studies focusing on male acrobats. Pre-existing research relied on "self-reported" data, which can lead to bias and limit the generalisability of findings. Individuals who are not vocal about their pain may be neglected.

The study's data collection was limited to article published within a 11-year timeframe. This decision was influence by the time constraints of the research, which was carried out as part of a MSc dissertation during 2022-2023. The search is set to understand the finding the last decade and restrict the inclusion of potential relevant older studies.

The article selection was carried out by single researcher, while this aim to minimize inter-researcher variability and ensure methodological clarity, it may introduce selection bias. Additionally, amongst the 28 studies reviewed, the search criteria included secondary literature, such as systematic reviews, risking double representation of primary studies. Despite efforts to remove duplicates, it is possible that some primary studies were indirectly cited through systematic reviews. The duplication can potentially influence the findings and generalisability of the review.

Despite the limitations, this evidence suggests that pain perception and varying degrees of self-efficacy influences one's behaviour towards pain, training and injury. Future research could benefit from comparing quantitative data on pain perception and self-efficacy within individuals and establish how it can inform the management of pain amongst acrobats

Declaration of interest statement

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