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A Systematic Review of Ankle Injury Epidemiology in Dance

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To systematically review the ankle injury epidemiology among dancers. Design: Systematic review. Data sources: MEDLINE, PEDro, Google Scholar, PubMed databases were searched from their inceptions to 17th of March, 2021. Reference lists of identified studies were hand-searched for additional relevant studies. The guideline for Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was adopted for this review. Inclusion criteria: Prospective or retrospective studies that reported musculoskeletal injury findings in a dance population, studies that reported only ankle injuries with prevalence percentage, or the incidence rate among the surveyed dancers or provided sufficient data from which these injuries were calculated. The qualities of the included studies were assessed using 11 criteria adapted from STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines. Results: 56 studies fulfilled the inclusion criteria. A weighted prevalence of 69.7% ankle sprain was found in this review. Ankle sprain, Achilles tendonitis, strain and anterior impingement syndromes were the most common ankle injuries in dance. The causes /mechanisms of the injuries included among others, falls from extremely planter-flexed position from pointe works, and poor landing techniques from jumps. Conclusion: The prevalence of ankle injuries in dance is high, the majority of studies on injuries in dance are retrospective in design and there is inadequate involvement of qualified medical personnel in dance. Recommendation: More prospective studies on dance injuries are needed and injury preventions guidelines should be introduced and emphasized at all times in dance.

Keyword: Dance injuries, epidemiology, ankle injuries, ankle sprains, overuse injuries.

INTRODUCTION

Dance has continued to grow in popularity worldwide. As an art, dance plays important roles in various societies either as an entertainment or as a form of artistic expression [1]. Universally, individuals take to dance either for recreational, social, or professional purposes. Dance encompasses various genres such as ballet, modern, contemporary, hip-hop, tap and African folk dance [2–4]. Quantitative and qualitative evidences abound that support dance as having numerous physical, psychological and social benefits [5]. These benefits include improved balance and body awareness; improved mood, mental well-being, fitness; and healthy body weights [6]. Dance is also reported to be a mind-body experience that increases blood supply to the brain, provides an outlet for releasing emotional expression, allows for creativity, and the socialization aspect lowers stress, depression, and loneliness [7]. Notwithstanding the numerous benefits associated with dance, there are still many concerns that irrespective of dance skill levels, dancers just as other athletes are susceptible to high levels of musculoskeletal injuries resulting from high intensity and repetitive bodily maneuvers.

In most dance forms, dancers move their bodies in repetitive rhythmic fashion to demonstrate their artistic expressions and athletic prowess while placing significant physical stress on their bodies [8]. Professionally, the physically demanding nature of dance is well documented [9]. Professional dancing often requires intense trainings, rehearsals and performances for perfection, as well as demanding repetitive bodily maneuvers [8]. Reports from previous pieces of research have shown that dancers as unique practitioners of arts and athleticism are particularly susceptible to musculoskeletal injuries and pain affecting the ankle joints [10–12]. Majority of these injuries are usually from overuse [13]; but traumatic injuries such as acute ankle sprains are also not uncommon [12]. Ankle injuries such as sprains are believed to be among the most traumatizing injuries among athletes[14] and perhaps, could be even more traumatizing for dancers compared to other athletes [15]. The vicious sequaele of ankle injuries, especially lateral ankle sprains, re-injuries, chronic ankle instabilities (mechanical and functional instabilities) and chronic ankle pain could be strong determinants of career longevity for many dance professionals. Among dancers, studies have shown that the majority of ankle injuries are mostly due to ankle inversion while the foot is in extreme planter flexion. In some cases, ankle injuries occur as a result of missed landing from heights or while rolling over the lateral border of the foot on demi-pointe [3, 15]. Furthermore, it has been reported that at least 40% of individuals who sustain a first time ankle sprain end up developing residual symptoms, often defined as chronic ankle instability [16]. The associated burdens of ankle injuries in dance are reported to be very high[17, 18] and include: reduced dance participation-time [18], income losses [19], and the exorbitantly high financial cost of managing the dance injuries for dance companies [20]. Therefore, the ankle injury burdens of dancers are worthy of attention for several reasons.

Van Mechelen et al, [21] had suggested that the first step towards injury prevention in sports is the identification of the burdens of injuries among athletes. In line with this thinking, Doherty et al [16] and Fong et al, [22] had conducted reviews of ankle injuries and sprains involving multiple sports. However, only nine dance studies were included in both reviews out of a combined total of 408 studies. In addition, none of the two reviews mentioned were specific enough to dance in nature and scope and thus did not fully cover the burdens of ankle injury and sprains in dance. Therefore, the aim of this study was to systematically review epidemiological studies on ankle injuries among dancers of all genres, dance skill levels and age groups in order to identify the distributions, weighted prevalence, incidences, injury causes/mechanisms, and associated factors of ankle injuries and sprains in dance.

METHODS

Study reporting, protocol registration and dance injury definition

The authors adopted the guidelines provided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement 23. Necessary ethical guidelines for the conduct of a systematic review were observed and the study was registered with PROSPERO (CRD 42020209286). Due to the variability of injury definitions in dance medicine community, the authors decided to define dance injury as any self-reported or clinically diagnosed bodily hurt, physical complaints, harm, or trauma sustained by a dancer as a result of participation in dance-related physical activities only, without minding the type (s) of care / medical attentions sought if any, or the amount of dance-participation time lost if any.

Data sources and searches

Two of the authors systematically and independently searched the databases of PubMed, Google Scholar, PEDro, and MEDLINE between 26th of March to 17th of March, 2021 for epidemiological studies related to ankle injuries among dancers. Reference lists of identified studies were hand-searched for additional relevant studies. Dancer-specific population and dance-injury specific search keywords were combined using Boolean operators (Fig. 1). The study searches were not restricted to any year of publication, participants' age, sex, skill levels or any

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particular dance types, but were only limited to studies published in English.

Inclusion criteria

To be eligible for inclusion, the study must: (i) have reported ankle injuries with prevalence percentage, or the incidence rate among the surveyed sample compared with other body sites or provide sufficient data from which these injuries were calculated. (ii) be either prospective or retrospective in design.

Exclusion criteria

Studies were excluded if they were (i) reviews (ii) conference proceedings (iii) case reports (iv) opinion papers and letters to the editors.

Critical Review of Included Literature

Two of the authors independently reviewed all the titles and abstracts generated from the searches to identify and exclude non-related studies. Full texts of eligible studies were retrieved and reviewed.

Data Extraction

Data from eligible studies were extracted into Microsoft Excel (Microsoft Corporation, Redmond, WA USA) for ease of synthesis. Relevant data extracted into Microsoft Excel included: age, sex of the dancers, nature of study, settings, dance injury definition and measurement of injuries, skill level of dancers, number of dance performances per week/month, number of years dancing, total injuries recorded, and activities when injuries occurred. Extracted also were: authors, year of publication, country of origin, sample size, study duration, types of injuries recorded, the most injured body sites, injury diagnosis, total number of ankle injuries, types of ankle injuries, prevalence/incidence rate of ankle injuries, time loss from the injuries and associated factors of the injuries.

Assessment of Study Quality

Two of the authors independently assessed the quality of the included studies based on 11 criteria adapted from the STROBE guidelines for rating observational studies [24] (Supplementary material). The guideline was previously used by Doherty et al [16]. Each study was considered as either low risk of bias (high quality) or high risk of bias (low quality) if it scored ≥7/11 or ≤6/11 respectively using the adapted STROBE Checklist. Two authors collated the final quality assessment ratings for the studies for harmonization of discrepancies. All disagreements were resolved by consensus between the reviewers and where consensus was not possible a 3rd author was consulted. After all disagreements were resolved and consensus reached, the final scores of the studies were collated by summation of all the criteria score out of a total of 11.

Calculation of ankle injury prevalence

The prevalence representing the ratio of the number of events (ankle injuries) occurring over a specified time to the study population was calculated16. The ankle injury prevalence were represented by weighted percentages, calculated by the sum of the percentages of ankle injuries, times the number of all ankle injury types in each included study, then divided by the sum of the total number of all ankle injuries [16,22]. The calculations are mathematically represented with the formula below:

$$Weighted\ percentage\ (ankle\ injuries) = \frac{\sum_{i=1}^{n} total\ ankle\ injuries\ X\ percentage\ (ankle\ injury\ types)}{\sum_{i=1}^{n} total\ ankle\ injuries}$$

Calculation of ankle injury incidence rate

Incidence rate was defined as the ratio of the number of events (ankle injuries) occurring during a specified time to the average population during the same period of time16. This calculation was adapted from the works of Doherty et al [16] and is as shown in the mathematical formula below:

$$Incidence\ per\ 1{,}000\ units\ of\ exposure\ (ankle\ injury) = \frac{Sum\ of\ ankle\ injuries\ commencing\ over\ a\ specified\ time}{Sum\ of\ exposure\ units\ for\ all\ included\ sample\ \times\ 1{,}000}$$

Articles that reported incidence were divided according to the unit of exposures used (e.g., per 1,000 athlete exposures or per 1,000 hour of exposure) and in situations where data was presented in other forms (e.g., per 10,000 units of exposure), such data were converted to a common unit of exposure.

RESULTS

Search Strategy

The database searches returned a total of 3,539 articles, thereafter, 2,197 duplicates were removed using Mendeley Software and 1,342 articles remained. The titles and abstracts of the 1,342 remaining articles were screened leading to the removal of 588 studies at this phase. At the end of title and abstract screening, 154 articles that remained were subjected to full-text screening for eligibility with the inclusion criteria applied. Thereafter, consensus was reached that, a total of 56 epidemiology studies met the inclusion criteria and were included in this study (Fig. 1).

Geographical distributions of the Studies

Most of the studies were conducted in Europe (43.3%) and North America (35%). Studies in Asia and Australasia constituted 8.3% each while 3.3% and 1.7% of the studies were conducted in South America and Africa respectively. United States of America was the country with the highest number of studies (30%) followed by Ireland (15%), (Table 1).

Years of study publication, nature of study, duration of study, types of dance, skill levels of dancers and number of dance participants.

The majority (67.9%) of the studies was published between 2011 and 2020. Retrospective study designs constituted 66.7% while a mix of retrospective and prospective studies comprised 33.3% of all the included studies. The study durations varied from one week 25 to 17 years [26, 27] with prospective longitudinal studies having the longest study durations. Ballet and Irish

dance were the predominant dance styles, constituting 37.9% and 15.2% of the studies respectively. Fifteen (26.8%) and nine (16.1%) were conducted among professional dancers and dance students respectively. Whereas two studies [28, 29,] did not specify the dance types they studied, another three studies [25, 28, 29,] did not specify the skill levels of the dancers that were recruited in their studies (Table 2).

Characteristics of the Included Studies

A total of 252,249 participants were involved in all the included studies. The studies with the minimum and maximum sample sizes had 15 and 240,037 participants respectively [28, 30]. More than 75% of the participants were females. Seven studies [11, 29, 31–35] and one study [36] recruited single-sex (female and male) only participants respectively. Seven studies (12.5%) [11,29,32,33,37–39,] one study (1.79%) [35], and another seven studies (12.5%) [39–45] respectively recruited children, adolescents and adults only participants. Forty one studies (73.2%) recruited combined samples of children, adolescent and adult participants. The age of all the participants ranged from 4 – 61 years. Also the body mass index (BMI) of the participants ranged from 17.3kgm-2 to 22.8kgm-2. Their dancing experience ranged from 1–22 years. The dance hours/ dance exposure per week of the dancers ranged from 1 hour to 40 hours.

Quality of included studies

The average quality rating of the included studies was 7/11. More than half (58.9%) of the studies scored ≥7/11 and were considered low risk of bias (high quality). Furthermore, none of the studies scored the maximum point (11). The highest rated studies [20, 31, 38,39,46,47] scored 9/11 points; while the least rated study [30] scored 3/11 points. Consensus was reached for all items on the checklist for each of the included studies (Supplementary material).

Number of injured participants, body parts injured and injury diagnoses

A total of 98.3% of the participants sustained 254,986 injuries to various parts of their bodies. 13,624 dancers recorded 19,153 injuries to their lower limbs. Whereas 4,997 dancers sustained injuries to their knees, 3,282 and 2,193 dancers recorded injuries to their foot and ankle respectively. 2,193 of the dancers reported a total of 5,529 ankle injuries. 17 studies used the diagnosis of medical personnel, 15 used self-reported injuries of the dancers themselves' [4,20,29,55,71], four studies reviewed the medical records of the dancers [28,45,53,70,] 11 studies used a mix of dancers' self-report/assessment by medical personnel and insurance/workers' compensation claims respectively.

Ankle Injury Diagnosis, Weighted Prevalence of the Injuries and Incidence of ankle injuries per 1000 Dance Exposure Hour (DEhr)

5,529 ankle injuries were sustained, out of which ankle sprain (3,854), Achilles tendonitis (830), ankle strain (303) and anterior impingement syndrome (134) were the most commonly diagnosed ankle injuries representing weighted percentages of 69.7%, 15%, 5.5% and 2.4% respectively. The incidence of ankle injuries among the participants was 2.7 per 1,000 dance exposure hours (DEhr) (Table 3).

Years of dance Experience, and number of dance performances (exposures) hours per week (DEhr)

Data on the years of dance experience for all the dancers was provided by 23 studies. The average years of dance experience was seven years. Information about the number of dance hours /dance exposures per week was available in 22 studies. The average hour of dance exposures (DEhr) per week was 15.2 hours. The least number of DEhr per week was one hour while the highest number of DEhr per week was 30.3 hours.

Causes/Mechanisms of Injury and Events when the injuries occurred

Twenty-one studies provided information on the major causes and mechanisms of the injuries. These included overuse [38,41,78,] fall from extremely planter-flexed position (on pointe work) [11,31,] generalized fatigue and muscle weakness 64 fall from jumps [27,31,46,] fall while lifting a dance partner 79, poor landing from a jump, hop or poor balancing techniques [1,46,] inadequate warm-up, poor dance techniques [41,] poor spinning attempts (pirouette), Polka, rant steps, bending and Galleys rotation [76.] Others are poor dance floors and surfaces 64 and training overloads [75.] Four studies reported that injuries occurred during dance rehearsals [1,27,41,67.] Three studies reported occurrence of injuries during dance trainings [27, 67, 80,] one study each reported injury occurrence during dance production [41,] during shows/major competitions [42] and during dance class performances [78.]

Associated Factors and Time Loss due to the Injuries

Information about the associated factors of the injuries was available in [47] studies. Seven studies reported overuse as the major associated factor [13,31,42,47,49–51, 13] studies [27–29,32,47,50,52,55,59,60,68,75,81] reported age (younger age < 12 and increasing age > 30 years) as the injury

associated factors, eight studies reported history of previous injuries [11,31,32,58,59,61,69,77,] gender was reported by six studies [26,27,39,45,52,67,] as injury associated factors. Three studies [57, 61, 63,] attributed ankle injuries to insufficient ankle ROM, while two studies [60, 62,] associated injuries to forced and compensated turnout. Number of years dancing was also associated with increasing prevalence of injuries [82.] Seven studies reported a mix of age, gender, poor conditions of dance floors, dancing with unhealed injuries, poor balance abilities, in appropriate warm-up and poor fitness as the associated factors of injuries. Finally six studies [20, 30, 34, 37, 70, 74,] did not report any data on injury associated factors. Fifteen studies [1,20,34,38,44,49,52,59,64,66,67,72–74,77] reported information on time loss due to injuries. The least and maximum time lost due to injury were one day [66] and 1,002 days [72] respectively.

DISCUSSION

The objective of this review was to systematically review ankle injury epidemiology among dancers. This review included [56] epidemiological studies published across the six continents of the world. Interestingly, the majority of the studies were published in most educationally developed continents (Europe, North America and Australia). This reflects the level of development of dance as a sport or entertainment career and an academic discipline in each of these regions. Dance as a discipline is well developed in Europe and North America and those continents have high number of institutions running dance programs [1] and are thus expected to have more research studies on dance-related issues including injuries.

The finding that majority of the studies in this review were retrospective indicates that retrospective research still dominates studies on dance injury. Retrospective study designs may not be the best approach to use for studying injury epidemiology in dance as such studies are prone to many challenges which may include injury recall bias among the participants. In addition, it is impossible to implement injury prevention programs and injury rehabilitation outcomes with retrospective studies [21.] Among all the studies reviewed, three studies [11, 28, 32] accounted for more than 45% of the participants, and none of them specified the type of dance genres or the skill levels of the participants. These drawbacks may be associated with the nature /methods of their data collection; ranging from national electronic injury surveillance system, social accident insurance institutional records to medical record reviews. These drawbacks could also be explained by the way injuries were defined, that is as, “any current or past medical history of physical constraints or when oral report of injury is clinically corroborated [32.] However, the strength of those studies lies in their being carried out over long durations ranging from two years to fifteen years [11, 32] Among studies that specified their dance types, Ballet and Irish dance were more prominent. This unsurprisingly reflects the dance cultures and the popularity of those dance genres in Europe and North America [1], which accounted for the majority of the included studies. Also, there were generally more female than male participants in the reviewed studies. Just as soccer is believed to be male-dominated sports [83,] the dominance of female gender in the reviewed studies may perhaps be attributed to the fact that dance is believed to be traditionally a female-dominated field [84]. The average quality rating of the studies included in this review was 7/11 which was the pass mark (≥7/11) set for this review. Criteria commonly unfulfilled by most of the studies that negatively affected their quality ratings were: the reporting of the methods of injury follow-ups and, how participants with missing injury data were accounted for. However, the two factors may be attributed to high rates of retrospective study designs among dance studies. Overall, the qualities of studies with prospective designs in the present review rated higher than those with either retrospective or mixed designs. Furthermore, considering that in the present study, only 17 studies involved qualified medical personnel for their data collection, it is expected that important details about the injuries may have been missed by studies that did not involve medical personnel, and this may have negatively affected the quality of those studies. Indeed, Doherty et al., (2013) had opined that when injury data collection is not based on objective medical diagnoses, investigator error through reporting bias may raise concerns about the internal validity of the studies.

The prevalence of ankle injuries found in this review is high. Most dancers begin training at a young age [17], therefore, it would be expected that sustaining micro-traumatic injuries and overuse syndromes such as Achilles tendonitis would be high. Also, considering that the dancers’ age in this review ranged from 4 to 61 years, it would be expected that high prevalence of acute ankle sprain among the dancers especially at a younger age would predispose the dancers to high rate of overuse injuries such as tendonitis and chronic ankle instabilities [14]. Interestingly, presence of high prevalence of overuse injuries such as ankle instabilities among the dancers may be attributed to low involvement of qualified medical professionals who are specialists in injury prevention and management. It could also be attributed to the fact that a significant percentage of dancers do not report their injuries for a variety of reasons [85], which may include fear of possible loss of performance engagement and loss of income. Unlike previous systematic reviews on musculoskeletal injuries [16, 17,22,79,86] the current review considered various specific diagnoses of injuries to the ankle in dance. This

is very important because categorizing injuries into specific diagnoses is paramount in evidence based injury preventions [87].

The high incidence of ankle injuries found in this review may be only an indication of the number of instances a new ankle injury may be sustained within a 1,000 dance exposure hours (DEhr). It is not an indication of ankle injury severities within the dance population. If the average years of dance experience and total DEhr/week are considered concurrently. The years of dance experience may be within range when compared with sports such as soccer, but the total numbers of dance exposure hours are higher than the average athletic exposure hours in soccer [88]. This may be an indication that there is a high rate of training overload in dance. Excessive dance training overloads among the dancers may be predisposing the dancers to increased job strains and fatigue which are known to result in high rate of musculoskeletal injuries especially high rate of ankle injuries [46, 89].

Among the causes / mechanisms of injuries reported by the included studies in this review were; fall from extremely planter-flexed position while performing pointe works, fall from jumps and while lifting a dance partner, poor balancing and poor landing techniques from jumps. Dance as a form or artistic athleticism with minimal person to person contact unlike soccer [83, 90] is associated with different kinds of maneuvers and extremes of range of motion especially at the ankles. These extreme ranges of motion for example, when standing on pointe (in ballet), are known to cause injuries at the foot and ankles [42]. However, the obvious lack of organized medical experts as team members in dance companies, and dance competitions may be worsening the injury rates as vital information on injury prevention strategies may be missing. Although dance medicine is still young [17, 79, 86], there appears to be insufficient emphasis on injury prevention in dance studies. The associated or risk factors for ankle injuries found in this review can simply be categorized as intrinsic and extrinsic risk factors. Factors such as age, gender, balance abilities or neuromuscular controls are intrinsic risk factors which may not be under the control of the dancers or the dance instructors. However, insufficient range of motion (ROM) forced and compensated turnout, and poor conditions of dance surfaces and floors as associated factors of injuries should be controlled to prevent high rate of injuries among dancers.

Clinical Implications

The high prevalence of ankle injury in dance has overall long term musculoskeletal health implications for the dancers as the injuries may result in mobility impairments if not properly managed. Secondly, unless injury prevention guidelines are introduced in dance, this high ankle injury prevalence may continue to grow as more people are beginning to take up dancing as profession. The obvious inadequate involvement of qualified medical personnel teams in dance is a serious health concern.

CONCLUSION

The prevalence of ankle injuries in dance is high. Sprains, Achilles tendonitis, ankle strain and anterior impingement syndromes are the commonest ankle injuries among dancers. The majority of ankle injuries and sprains among dancers are caused by fall from extremely planter-flexed position while performing pointe works, fall from jumps, fall while lifting a dance partner, poor landing from a jump, and poor balancing and spinning attempts, inadequate warm-up, poor choreography techniques, poor spinning attempts (pirouette), Polka, rant steps, bending and Galleys rotations. Others are unsuitable dance floors and surfaces and dance training overloads. The associated factors of ankle injuries and sprains include age (younger age < 12 and increasing age > 30 years), female gender, insufficient ankle ROM, forced and compensated turnout, poor dance surfaces and floors, number of years dancing, inappropriate warm-up and poor fitness. Findings from this systematic review will provide valuable information for those interested in prevention and treatment of ankle injuries from dance.

RECOMMENDATIONS

Injury prevention guidelines should be introduced in dance. There are many associated factors to injuries among dancers identified in this review but questions remain on the influences of those factors on injury prevalence and severity among dancers. This area needs further investigations. The majority of the included studies in this review used outcome measures for their data collection without stating the psychometric properties of the instruments. In addition, most of the studies on dance are still retrospective in nature, and dance injury diagnoses are mostly based on the dancers' self report, rather than objective medical diagnoses. Therefore, future studies need to investigate the reliability of outcome measures for dance musculoskeletal injury epidemiology, and the influences of health professionals' pre-participation screening of dancers on injury prevention outcomes.

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Table 1: Geographical /Geopolitical distribution of the studies included in this review

Continents (n)	%	Countries (n, %)
Africa (1)	1.7%	South Africa (1)
Asia (5)	8.3%	India (1), Republic of Korea (1), Isreal (3)
Australasia (5)	8.3%	Australia (3), New Zealand (2)
Europe (26)	43.3%	Italy (1), Germany (3), Greece (1), Ireland (9), Netherland (2), Norway (1), Slovenia (1), Sweden (2), Turkey (1), UK (5),
North America (21).	35%	Canada (3), USA (18)
South America (2)	3.3%	Brazil (2)
Total (60)*	100%	

*Key: *The total count exceeds the number of studies included in this review as some studies Reported findings in more than one country*

Table 2: The period of study, nature of studies, types of dance, skill level of dancers and number of dance participants investigated.

Period of study	No. of studies; n (%)	No. of dance participants; n (%)
Pre - 1980	0 (0.00)	0 (0.00)
1981 - 1985	2 (3.57)	266 (0.11)
1986 - 1990	2 (3.57)	1555 (0.62)
1991 - 1995	1 (1.79)	200 (0.08)
1996 - 2000	1 (1.79)	455 (0.18)
2001 - 2005	5 (8.93)	229 (0.09)
2006 - 2010	7 (12.50)	906 (0.36)
2011 - 2015	19 (33.93)	6870 (2.72)
2016 - 2020	19 (33.93)	241768 (95.84)
Study designs		
Prospective	17 (26.98)	2191 (0.87)
Retrospective	42 (66.67)	248435 (98.49)
Mixed (Retrospective + Prospective)	4 (6.35)	1623 (0.64)
Types of dance		
Aerobic dance	1 (1.52)	726 (0.29)
Anatolia (Turkish) folk dance	1 (1.52)	82 (0.03)
Ballet dance	25 (37.88)	3281 (1.30)
Bharatnayam traditional dance	1 (1.52)	215 (0.09)
Break dance	2 (3.03)	223 (0.09)
Contemporary dance	3 (4.55)	749 (0.30)
Hip Hop dance	4 (6.06)	319(0.13)
Irish dance	10 (15.15)	914 (0.36)
Jazz	4 (6.06)	889 (0.35)
Modern dance	9 (13.64)	1389 (0.55)
Morris dance	1 (1.52)	523 (0.21)
Pediatric dance	1 (1.52)	181 (0.07)
Theatrical dance	1 (1.52)	218 (0.09)
Not specific (N/A)	3 (4.55)	242540 (96.15)

Dance skill levels		
Amateur dancers	2 (3.57)	659 (0.26)
College level ballet dancers	1 (1.79)	30 (0.01)
Competitive dancers	2 (3.57)	629 (0.25)
Dance students	9 (16.07)	1544 (0.61)
Elite professional dancers	6 (10.71)	644 (0.26)
Non-professional dancers	4 (7.14)	1605 (0.64)
Pre-professional dancers	6 (10.71)	1311 (0.52)
Professional dancers	15 (26.79)	2149 (0.85)
Recreational dancers	3 (5.36)	1459 (0.58)
Semi-professional dancers	5 (8.93)	1285 (0.51)
Not specified	3 (5.36)	242540 (95.51)

Key: * The total count exceeds the number of studies included in this review as some studies adopted a mixture of study designs and types of dance.

Table 3: Ankle Injury Diagnosis, Weighted Prevalence of the Injuries, Incidence of ankle injuries 1000 Dance Exposure Hours (DEhr)

Ankle injury diagnoses	**Freq.**	**Weighted %**	**Incidence /1000 DEhr**
Sprain	3854	69.70	
Distortion dig pedis	19	0.30	
Ankle synovitis	38	0.70	
Achilles tendon rupture	5	0.10	
Dorsal impingement	24	0.40	
Anterior impingement	134	2.40	
ankle tenosynovitis	65	1.20	
Syndesmosis	75	1.40	
Peroneal tendonitis	5	0.10	
Retro-calneobursitis	4	0.10	
Achilles tendonitis	830	15.00	
Stress fracture	35	0.60	
Strain	303	5.50	
Ankle instability	11	0.20	
Undiagnosed ankle injuries	127	2.30	
Total	**5529**	**100.00**	**2.7**

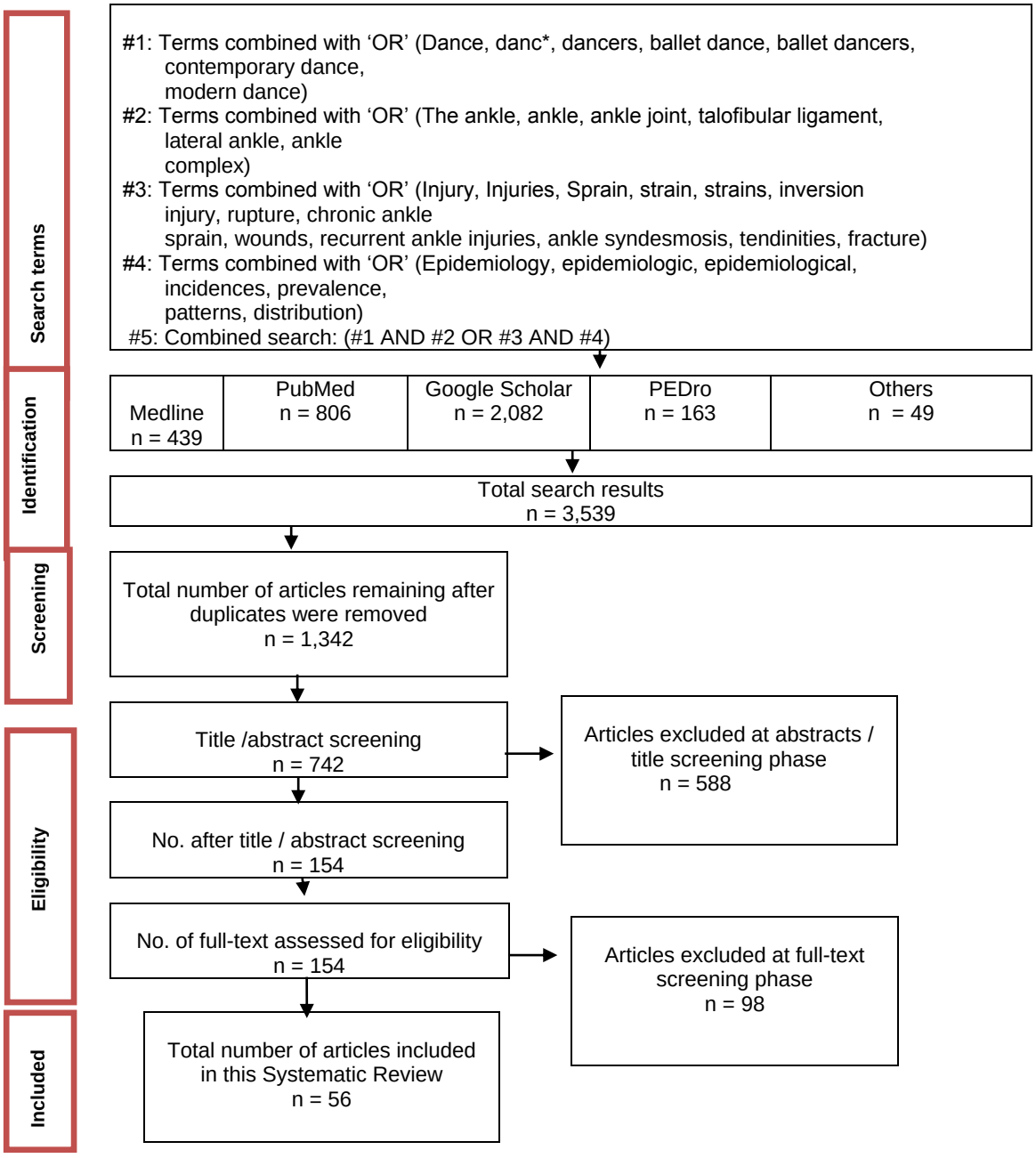

Figure 1: PRISMA diagram of the search strategy and study selection processes.

Supplementary material: Results of adapted version of the STROBE guidelines for quality assessment of included studies (11 checklist criteria).

Checklist criteria												
Ref	**Prd of datcoll**	**Set/ part locat**	**Def of inj**	**Injverif by an indep. Med. pers.**	**Ethics clear & consent obtained**	**Incl & excl crit**	**Measures & presents exposure data**	**Ankle /sprain injury history**	**Classif ankle inju acc to spec diag**	**Meth of inj follow-ups given**	**Exp how parti miss with injudatweraddrsd**	**Total score (11)**
48	1	1	1	0	1	1	0	1	1	0	0	7
40	1	1	1	1	1	1	1	1	0	0	0	8
13	1	1	1	0	1	1	0	0	0	0	0	5
41	1	1	1	0	1	1	1	1	0	0	0	7
49	1	1	1	1	1	1	1	1		0	0	8
50		1	1	1	1	1	0	0	1	0	1	7
51	1	1	1	1	0	0	1	1	0	0	0	6
52	1	1	1	1	1	1	0	1	1	0	0	8
31	1	1	1	1	1	1	1	1	1	0	0	9
53	1	1	1	1	1	1	1	0	0	0	0	7
54	0	1	0	0	1	1	0	1	1	0	0	5
55	1	1	1	0	0	0	0	1	1	0	0	5
32	1	1	1	1	0	0	1	1	1	0	0	7
11	0	1	1	1	1	1	1	1	1	0	0	8
56	0	1	0	0	1	1	1	1	1	0	0	6
33	0	1	0	1	0	0	1	1	1	0	0	5
57	1	1	1	1	0	0	0	0	0	0	0	4
28	1	1	1	0	0	0	0	1	1	0	0	5
42	0	1	0	1	1	1	0	1	1	0	0	6
27	1	1	1	1	0	0	0	1	1	0	1	7
58	1	1	1	1	1	1	0	1	1	0	0	8
37	1	1	1	1	1	1	0	1	1	0	0	8
34	1	1	1	0	0	1	1	1	1	0	0	7
59	1	1	1	1	1	1	0	0	0	0	0	6
43	1	1	1	0	1	1	1	0	0	0	0	6
60	1	1	1	1	1	1	0	1	0	0	0	7
61	1	1	1	1	1	1	1	1	0	0	0	8
62	0	1	1	0	1	1	0	1	0	0	0	5
30	0	1	0	0	1	1	0	0	0	0	0	3
63	1	1	0	1	1	1	0	0	0	0	0	5
46	1	1	1	1	1	1	0	1	1	0	1	9
1	1	1	1	0	1	1	1	1	1	0	0	8
64	1	1	1	0	1	1	0	0	0	0	0	5
65	1	1	1	1	1	1	0	0	0	0	0	6
66	1	1	1	1	1	1	1	1	1	0	0	9
38	1	1	1	1	1	1	1	1	1	0	0	9

47	1	1	1	1	1	1	1	1	1	0	0	9
36	0	0	0	1	1	1	1	1	1	0	0	6
67	0	1	0	1	1	1	1	1	1	0	0	7
68	1	1	1	0	1	1	0	1	0	0	0	6
69	1	1	1	1	1	0	0	0	0	0	0	5
70	1	1	1	1	0	0	0	0	0	0	0	4
71	0	1	1	1	1	1	0	1	1	0	0	7
72	0	1	0	1	1	1	1	1	1	0	0	7
44	1	1	1	0	1	1	1	1	1	0	0	8
73	1	1	1	0	1	1	1	1	1	0	0	8
45	1	1	0	1	0	0	0	1	1	0	0	5
20	1	1	1	1	1	1	1	1	1	0	0	9
25	1	1	1	0	0	0	1	1	1	0	0	6
74	1	1	1	1	1	0	0	1	1	0	0	7
75	1	1	1	0	1	1	1	1	0	0	0	7
29	1	1	1	1	1	1	0	1	0	0	0	7
35	1	1	1	0	1	1	1	1	0	0	0	7
76	1	1	1	0	1	1	0	1	1	0	0	7
77	1	1	0	0	1	1	1	1	0	0	0	6
26	1	1	0	1	1	1	1	1	1	0	0	8

Keys: *1 Criteria met, 0 Criteria not met, *Unable to determine, scored 0, Ref = reference, Prd of datcoll = Period of data collection, Set/ part locat = Setting / participants locations, Def of inj = Definition of injury, Injverif by an indep Med Pers = Injury verified by an independent medical professional, Ethical clearance & consent obtained, Incl & excl crit = Inclusion and exclusions criteria stated, Classif ankle inju acc to spec diag = Classified ankle injuries according to specific diagnosis, Meth of inj follow-ups = Methods of injury follow-ups stated, Exp how parti with miss injudatweraddrsd = Explained how participants with missing injury data were addressed.*