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Musculoskeletal Injuries in Dance: A Systematic Review

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Abstract

Background: Within sport, mitigation of risk of injury through the use of comprehensive specialist sports medicine provision is commonplace. Dance participation, through its athletic nature can also introduce risk of injury, but unlike sport, is not always recognised that specialist medicinal provision will assist in the mitigation of that risk.

Objectives: This systematic review has two objectives: to examine the extent of injury in dance participation; and the impact that specialist dance medicine provision has on overall dance injury incidence.

Data sources: The review was undertaken using the Medline electronic databases using MeSH terms relating to the framing question.

Study Eligibility Criteria and Participants: The study was based on ballet or any forms of artistic dance that had as its focus musculoskeletal injuries, or screening for injury prevention or interventions to reduce musculoskeletal injury.

Interventions: The use of specialist dance medicine provision programmes including in-house medical teams, screening and exercise programmes

Study appraisal and synthesis methods: As the literature relating to dance injury comprised of observational studies, the GRADE system was utilised.

Results: The results of this systematic review reflect those of two previous systematic reviews in that little progress has been made in terms of quality of papers in recent years. On overall injury incidence of 1.33/1000hrs and a reduction in injury from 2.46/1000hrs to 0.84/1000hrs due to the impact of specialist dance medicine provision was calculated.

Limitations: PubMed was not utilised as the search required medical subheadings and therefore the exclusion of unpublished work/thesis, poster presentations and abstracts along with chapters from books may reduce the total number of studies available from which evidence and recommendations can be drawn

Conclusions and implications of key findings: An overall recommendation was made that, in the absence of stronger evidence, those involved with organising participation in dance consider the value of specialist medical provision. In addition, due to the low level of evidence reviewed, a call for consensus on injury data collection in dance is made to improve the quality of evidence in dance injury literature.

Keywords: Epidemiology; Prevention; Dance; Incidence; Injury

Introduction

Sport participation entails a risk of injury. Part of the responsibility of those charged with caring for sports persons is to mitigate that risk. Some of this may be achieved through the introduction of measures to minimise injuries. Dance participation, like sport, can lead to injury, however, unlike most and elite sports persons, many dancers do not have ready access to specialist or in-house medical teams. With the absence of international (e.g. International Olympic Committee, Fédération Internationale de Football Association- FIFA, and International Rugby Board) or national legislative governing bodies (e.g. Football Association, Rugby Football Union) dance has a relative lack of accountability governing how their participants are supported. As part of an injury prevention strategy in dance, an understanding of the extent of injuries is needed. Furthermore, knowledge of the impact of specialist and in-house medical provision in reducing injuries is required to inform those involved in delivering dance training and performance.

To date two systematic reviews pertaining to musculoskeletal injuries in dancers have been published. The first was designed to assemble and synthesize, using the "best evidence synthesis" approach, the epidemiology, diagnosis, prognosis, treatment and prevention of musculoskeletal injuries and pain in the dancing population up to October 2004 [1]. Through the application of a priori criteria 32 articles were accepted for review. The authors comment that 69% of the articles identified from the titles and abstracts were consequently not accepted following full text review due to lack of scientific vigour. Of the studies accepted Hincapie et al. [1] indicates the literature has many limitations resulting in difficulty in drawing consistent conclusions. The limitations include: the variety of injury definitions used; the heterogeneous nature of the populations; failure to identify the population at risk that should form the denominator in incidence (or prevalence) calculations; and the wide range of inclusion and exclusion criteria. Hincapie et. al. [1] does offer some important conclusions despite these limitations, including evidence that musculoskeletal injury is an important issue for all dancers and that there is preliminary evidence that comprehensive

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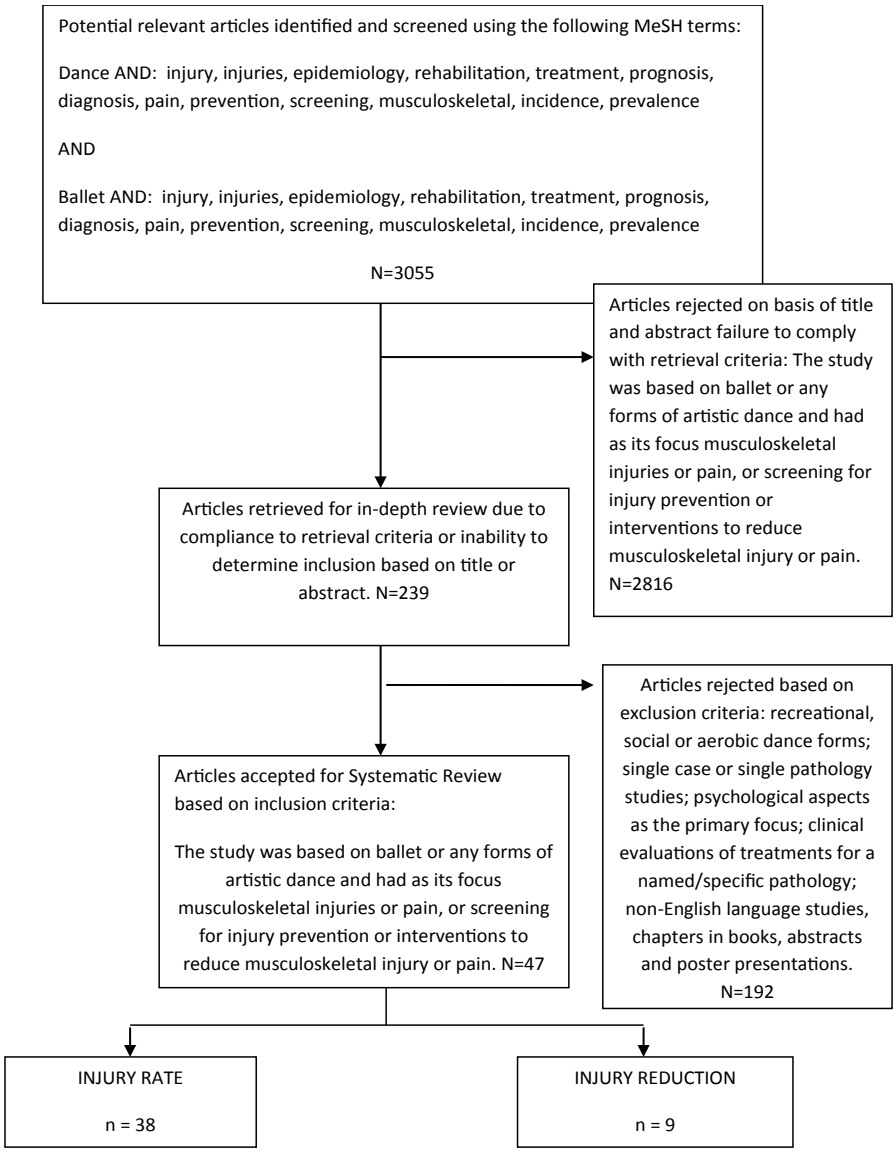

Figure 1: Schematic of systematic retrieval of studies.

injury prevention and management strategies may reduce injuries. In a follow-up to the original Hincapie et al. review [1], Jacobs et al. [2] extends the review period from October 2004 to March 2008. Repeating their methodology the authors reviewed a further 19 articles that were deemed scientifically admissible (with similar reasons for exclusion noted as per their previous review). The authors comment on an increase in the percentage of admissible studies rising to 68% compared to the 31% noted in the previous review. Jacobs et al. [2] still reiterate the need for explicit criteria on injury definition and methods of injury reporting and comment that there are still major scientific limitations and biases in the literature reviewed.

These two systematic reviews demonstrate that it is important to evaluate the evidence on musculoskeletal injuries in dancers and that due to an increasing emphasis on scientific rigor in dance medicine related articles, an up-to-date position needs to be established. Guidelines based on the evidence needs to be established that acknowledge the evidence profile from which they are based. There is a need to create recommendations for dance using recognised methodologies such as the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system, to evaluate both high and low level evidence [3-14].

The objectives of this review was to undertake an up-to-date systematic review and evaluation the level of evidence of the literature pertaining to musculoskeletal injury in dancers using the GRADE system. Furthermore to examine the impact that specialist dance medicine provision, including in-house medical teams, screening and exercise programmes, has on overall dance injury incidence and using the GRADE system to establish the level of evidence and strength of recommendations for its use in reducing the overall incidence of injuries in dancers.

Method

This systematic review of literature pertaining to musculoskeletal injuries in dance and evaluation of the impact of specialist dance

medicine provision on overall dance injury incidence was undertaken using the GRADE system. The value of implementing GRADE is the ability to evaluate high and low level evidence studies. This is an important aspect when considering the evaluation of dance injury literature as it has already been established to be of a low level. Furthermore the value of GRADE is that the direction and strength of recommendations takes into consideration the level of evidence from which it is drawn but evaluates if the proposed benefits outweigh any harm and so may differ from the evidence profile. The use of the Evidence to Recommendation Framework enhances the transparency of those recommendations. The GRADE system also allows studies with, for example differing injury definitions to be included to improve the sample size from which the data is drawn, but downgrades the overall confidence in results due to its evaluation of its heterogeneous nature [3-14].

Literature Review

A framing question was set prior to commencing the literature review: To evaluate the available literature from 1966 to 2013 to determine the level of evidence around musculoskeletal injury rates in dancers and the potential impact that specialist dance medicine provision may have on overall injury rate and pain. For the purpose of inclusion, "specialist dance medicine provision" programmes included implementation of in-house dance medicine teams, screening and exercise programmes [15-27].

A systematic search of the scientific literature was then undertaken using the following electronic databases: the Cochrane Library; Medline (1966-April 2013); the Allied and Complementary Medicine Database (AMED); Cumulative Index to Nursing and Allied Health (CINAHL 1966-2013); SPORTDiscus (1985-April 2013); and the International Bibliography of Theatre and Dance (1984- April 2013). If there was insufficient information in the title or abstract to determine its inclusion a full text manuscript was retrieved and a review was undertaken with the full inclusion and exclusion criteria applied. Applying the inclusion and exclusion criteria (Figure 1), two authors appraised the relevance of each identified study in order to agree the final list of included studies [28-44].

Critical Review of Included Literature

Each included study was summarised in a Table 1. This included data relating to methods, sample size and duration, injury definition, incidence or prevalence outcomes, severity outcomes and nature of intervention. The data collected allowed two key patient important outcomes to be determined, namely Injury Rate as an important outcome and Injury Reduction as a critical outcome. These outcomes were then used to determine the quality of the evidence presented and the strength of subsequent recommendations [14].

The rating of evidence was achieved through the Evidence Profiles for the respective patient important outcomes within which an evaluation of the evidence in relation to limitations, inconsistency, indirectness, imprecision and publication bias across the studies. Optimal Information Size (OIS) was calculated using a sample size calculator: the OpenEpi sample size calculator for a descriptive study where sample size:

$$n = [DEFF*Np(1-p)]/ [(d2/Z21-\alpha/2*(N-1)+p*(1-p)]$$

(http://www.openepi.com/OE2.3/SampleSize/SSPropor.htm). The Evidence Profile for injury incidence includes a calculation of the mean injury incidence per 1000hrs with 95% Confidence Intervals (CI) and number of injuries per dancer per year across the relevant studies with 95% CI. The Evidence Profile for injury reduction includes a calculation for the pre-intervention mean incidence/1000hrs, range and 95% CI, or number of injuries (and range) and a test/post-intervention mean injury incidence/1000hrs or number (and range). This repeated measures methodology is employed due to the absence of any control groups used in the intervention studies.

The development of the recommendations for the overall reduction of injuries in dance involved the balance between desirable and undesirable outcomes and the application of patient focussed values and preferences to determine the direction of the recommendation. These issues were taken alongside the quality of the evidence to then determine the strength of the recommendation.

Results

A total of 3055 titles and abstracts of studies were reviewed. Applying the retrieval criteria 239 studies were retrieved for full, in-depth review. Using the inclusion and exclusion criteria, 47 were then accepted and preceded to evaluation as part of this systematic review (Figure 1).

The majority of the studies related to ballet and modern or contemporary dance but other styles included break-dance, hip hop, theatrical dance, Mexican, Spanish, tap, Morris, flamenco, Irish, highland, jazz or a mix of styles. Participants were from professional or competitive dance backgrounds as well as student or vocational dance environments. Of studies accepted, 36 were conducted using a retrospective methodology including review of medical records or surveys while only 9 were prospective methodologies with a further two studies combining both retrospective and prospective components. Injury definitions varied between time loss to medical records or seeking medical attention to financial outlay. Some studies did not explicitly indicate the injury definition used. Details of injury were reported in a number of ways, including incidence, prevalence, injury per dancer or total numbers of injuries but very few papers reported severity of injuries (Table 1).

Within the Evidence Profile for Injury Rate (Table 2) a mean incidence of 1.33/1000hrs for the 12 observational studies that reported incidences of injury was calculated. An average of 1.93 injuries per dancer per year was calculated from 29 studies that had sufficient data.

These studies demonstrated serious limitations (including the lack of the inclusion of control populations and flawed exposure measurements), and inconsistencies (including the discrepancy of results within the studies and heterogeneity). There was no imprecision (on account of the sample size (n=2788 and 5318) being greater than the sample size calculated (n>385) [61]), indirectness, or publication bias noted. This resulted in a downgrading of the Low evidence assigned to observational studies within the GRADE system to Very Low.

The Evidence Profile for Injury Reduction noted a reduction from a mean incidence of 2.46/1000hrs to 0.84/1000hrs. There are no comparison groups for these studies as repeated measures methodologies were employed across the entire cohort studied. These 2 observational studies demonstrate serious limitations (due to the lack of the inclusion of control populations), inconsistency (due to the range of results reported and heterogeneity) and imprecision (due to the sample size n=363 being less than the sample size calculated n>385). Publication bias is also likely with both studies demonstrating significant reductions in injury incidence and thus more likely to be favoured for publication over studies that failed to demonstrate statistically significant findings. With these factors in mind the Evidence Profile rating is downgraded from Low for observational studies to Very Low (Table 3).

Author/ year	Participants/ level, Style	Method	Sample size/ duration	Injury definition	Outcomes: incidence/ prevalence	Outcomes: Severity (time loss in days)	Intervention	Limitation	In-consistency	In-directness	Im-precision	Publication bias
Baker et.al. (2010) [45]	Contemporary students	Retrospective survey	57/ Sept 2006-June 2007	physical damage to the body or body part which prevented completion of one or more entire curriculum class	75 injuries on total	not reported		serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Scialom et.al. (2006) [46]	professional contemporary	retrospective survey	30	"their most important injury"	not indicated specifically	not reported		serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Rietveld (2000) [47]	dancers and dance teachers>45 years, all styles	Retrospective medical records	66/April 1993-March 1996	medical attention	total 92 injuries, 1.4 injuries/ dancer	not reported		serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Pearson & Whitaker (2012) [48]	ballet students	Retrospective survey	67	occurred or was first noticed during ballet practice	36 dancers (55%) reported a relevant injury			serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Solomon et.al. (1995) [49]	professional ballet	Retrospective	70/1 year	medical attention	137 total (male: 58, female: 79)	101 injuries classified as grade 1: less than a week away; 34 injuries grade 2: one week or more.	self-insurance against medical costs	serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Solomon et.al. (1996) [50]	professional ballet	retrospective	70/year 1; 60/year 2;60/year 3	medical attention	year 1:137; year 2:128; year 3:88	not indicated	injury audit, in-house medical provision	serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Solomon et.al. (1999) [51]	professional ballet	retrospective	70/year 1; 60/year 2;60/year 3; 60/year 4; 59/year 5	medical attention	year 1: 137; year 2:128; year 3:96; year 4:98; year 5: 101		injury audit, in-house medical provision	serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Nilsson et.al. (2001) [52]	professional ballet	retrospective/ prospective cohort	98 dancers/5 years	medical attention	0.6/1000hrs	median full withdrawal 2.3 weeks		serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Pedersen & Wilmerding (1998) [53]	student and professional flamenco dancers	retrospective survey	80 dancers-injury data collected over lifetime of dance	not explicit but injuries sustained during participation in flamenco	50 injuries in total (20 to students, 30 to professionals)			serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Pedersen & Wilmerding (1998) [53]	student and professional flamenco dancers	retrospective survey	80 dancers-injury data collected over lifetime of dance	not explicit but injuries sustained during participation in flamenco	50 injuries in total (20 to students, 30 to professionals)			serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Ramel & Moritz (1994) [54]	professional ballet	retrospective survey	128/ injury data collected in relation to last 12 months	From the Nordic Questionnaire, "any trouble (ache, pain, discomfort)"	121 dancers reported experiencing some trouble, 472 problems reported.	168 problems prevented dancers doing their daily work.		serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Ramel et.al. (1999) [55]	professional ballet	retrospective survey	51 over 12 months	From the Nordic Questionnaire, "any trouble (ache, pain, discomfort)"	443 problems reported in 1995 (compared to 403 to the same 51 dancers in 1989)	1995:132 injuries causing incapacity in last 12 months; 1989: 161 injuries causing incapacity in last 12 months		serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Evans et.al. (1996) [56]	professional Broadway dancers and actors	retrospective survey	318 over the duration of the Broadway production (166 dancers)	self-reported	for 166 dancers: 218 injuries in total			serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected

Quirk (1983) [57]	student and professional ballet	retrospective medical records	664/15 years	medical attention	2113 injuries			serious limitations	No serious inconsistency	no serious indirectness detected	No im-precision	undetected
Chmelar et.al. (1987) [58]	professional and student ballet and modern	retrospective survey	39 dancers/	taken from the questionnaire: "have you sustained any major injuries that have kept you away from dancing for more than 2 or 3 weeks; do you have any recurrent physical nuisances that interfere with but do not stop your dancing	46 injuries			serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Bowling (1989) [58]	professional modern and ballet	retrospective survey	141 dancers/ 6 months recall	self-reported injury	118 dancers had at least one injury			serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Bronner & Brownstein (1997) [59]	professional Broadway dancers	medical record review	30 dancers/ 7 weeks	time loss from performance	40% injury rate; 1.0injuries/ dancer	82 missed and 35 partial performances		serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected
Nunes et.al. (2002) [60]	recreational ballet	questionnaire	31 dancers (12 non-Pointe, 19 Pointe)	no explicit-reports painful sites	mean number of painful sites reported. Non-Pointe: 1.3; Pointe 2.9			serious limitations	No serious inconsistency	no serious indirectness detected	Im-precision	undetected

Table 1: Severity of injuries.

No of studies (design)	Limitations	Inconsistency	Indirectness	Imprecision	Publication bias	Average incidence/1000hrs (Range of incidence/1000hrs) (95%CIs)	Actual no. of injuries/ no of participants/year (range) (95%CIs)	Quality
Overall injury incidence 29 (observational)	serious limitations	serious inconsistency	no serious indirectness detected	no imprecision	undetected	1.33injuries/1000hrs (0.18-4.7injuries/1000hrs) (0.20-4.35)*	1.93 injuries/dancer/year (0.05-6.83)(0.29-4.5)	very low
*based on 12 studies								

Table 2: Evidence Profile- *Injury Rate* (Injury Incidence and No. of Injuries).

No of studies (design)	limitations	inconsistency	indirectness	Imprecision	Publication bias	Total number of injuries (Range of incidence/1000hrs) (95%CIs)	Test/ post-intervention: Average incidence/1000hrs (Range of incidence/1000hrs)	Quality
Comprehensive medical provision 2 (observational)	serious limitations	serious inconsistency	no serious indirectness detected	serious imprecision	likely	2.46/1000hrs (0.52-4.4/1000hrs)	0.84/1000hrs (0.18-2.1/1000hrs)*	very low
*representing/over 7 years								

Table 3: Evidence Profile- *Injury Reduction* (Injury Incidence).

A further 3 observational studies demonstrated a reduction in injury numbers from 137 to 106. These studies also demonstrated serious limitations (due to the lack of the inclusion of control populations) and imprecision (due to the less than optimal information sample size) and so the Evidence Profile was rated down from Low to Very Low (Table 4).

Using the GRADE framework for moving from evidence to recommendation, a recommendation for the use of comprehensive medical management for the reduction of injury rate in dancers is advocated in the absence of stronger evidence (Table 5).

Discussion

The aim of this review was to provide an up-to-date systematic review of the literature pertaining to musculoskeletal injury and pain in dancers using the GRADE system to establish the level of evidence and strength of recommendations for reducing the overall incidence of injuries in dancers. When examining the literature retrieved through this systematic review similar findings to the two earlier studies are noted with many limitations including the variety of injury definitions used, the heterogeneous populations; identifying the at risk population and the wide range of inclusion and exclusion criteria [1,2]. An overall injury incidence of 1.33/1000hours, and an injury reduction as a consequence of comprehensive medical management from 2.46/1000hrs to 0.84/1000hours was calculated.

GRADE evidence profile

One of the fundamental aspects of the GRADE system is that sequential judgements are made regarding the quality of evidence across studies for each patient important outcome [4]. It determines which outcomes are critical to a decision and the overall quality of evidence across those critical outcomes. This includes the balance

No of studies (design)	limitations	inconsistency	indirectness	Imprecision	Publication bias	Control/ pre-intervention: Average injury numbers (Range of total injury numbers)	Test/ post-intervention: Average injury numbers (Range of injury numbers)	Quality
Comprehensive medical provision 3 (observational)	serious limitations	no serious inconsistency	no serious indirectness detected	serious imprecision	likely	137 (137)	106 (96-128)*	very low
* representing/over 4 years								

Table 4: Evidence Profile - *Injury Reduction* (injury numbers).

Question/recommendation: Should comprehensive (in-house) medical management vs. off-site medical referrals be used to reduce injury rate in professional dancers				
Population: Professional dancers (ballet and modern)				
Intervention: Comprehensive In-house Medical Management (including Injury audit/Screening/Intervention programs) vs. offsite medical referrals				
Setting: Professional dance companies				
Decision domain	Judgement		Reason for judgement	Sub domains influencing judgement
	Yes	No		
Balance of desirable and undesirable outcomes: Given the best estimate of typical values and preferences, are you confident that the benefits outweigh the harms and burdens or vice versa?	x		The desirable outcomes are a reduction of injury rate. There is no evidence to suggest the use of in house comprehensive medical management would be detrimental to the patient group	The size and specialities within the comprehensive medical management has not been established. Similarly if differences are needed for various sub-group populations, i.e. ballet or modern?
Confidence in estimates of effect (quality of evidence): Is there high or moderate quality evidence		x	The evidence profile for this outcome is very low for the desired outcome. There is no evidence to any detrimental/harm outcome through utilising this intervention	Key reasons for rating down of evidence is through the use of observational studies with certain limitations in the GRADE rating factors
Values and preferences: Are you confident about the typical values and preferences and are they similar across the target population?	x		We can be confident that professional dancers place a high value on a reduction in injury rate as their livelihood is dependent on their ability to dance	The increasing number of higher quality studies into injury rate reflects the position of the dance environment
Resource implications: Are the resources worth the expected net benefit from following the recommendation?	x		There is a resource need to provide in-house medical provision. This has been demonstrated to reduce the overall medical costs and outweigh the costs of its implementation.	Although not explicitly examined as part of the review, the use of in-house medical teams are becoming more common place- the implementation of injury audits, screening and program interventions could be seen as sunk costs. Cost per resource unit needs to be established.
Overall strength of recommendation	Strong		The author recommends that the injury rate of dancers in professional companies will be reduced through the use of comprehensive medical management.	
Evidence to recommendation synthesis	The high value placed on injury reduction through comprehensive medical management versus harm outweighed the lower evidence profile in the absence of stronger evidence			

Table 5: GRADE Recommendation for Injury Reduction.

between benefits and harms, and the strength of the subsequent recommendations [62].

From the literature retrieved, 29 studies were used in an evidence profile for Injury rate (injuries/dancer/year) of which 12 allowed injury incidence to be considered. With the studies there were serious limitations or biases noted due to the failure to include control groups, flawed measurements of exposure and failure to control confounding variables including a failure of accurate measurement of all known prognostic factors and failure to match for prognostic factors. The studies in question were also noted for serious inconsistency due to the heterogeneous nature of the contributing studies. It is well appreciated that various dance styles provide differing challenges on the body [63,64] that may result in injuries as well as the potential differences in injury potential noted between professional and student participants [15,16,26]. As the pooled sample size for Injury Rate (n=2788 and n=5319) was greater than the n=385 generated by a conventional sample size calculation for a single adequately powered trial it was not rated down for imprecision. There was no evidence of publication bias noted in this outcome group. As a consequence of these issues in the absence of any upward rating through magnitude of effect, dose response or confounders likely to minimise the effect, the overall rating of Low evidence for observational studies is downgraded to Very Low as a reflection of the overall confidence in the effects.

Similar issues over evidence were observed when considering Injury Reduction as a patient important outcome. There were serious limitations or biases noted due to the failure to include control groups, flawed measurements of exposure and failure to control confounding factors. The studies in question were also noted for serious inconsistency due to the heterogeneous nature of the contributing studies, although these studies were limited to professional ballet and modern dancers as opposed to the range of patient groups noted in the Injury Rate Evidence Profile. The pooled sample size (n=363) for Injury Reduction was less than the required sample size of 385 so therefore was rated down for imprecision. It was also noted that publication bias was likely due to the statistical significance reported in studies resulting in their acceptance for publication as opposed to studies that may not have demonstrated significant findings. As a consequence of these issues the overall rating of Low evidence for observational studies is downgraded to Very Low.

GRADE recommendations

The nature of the important outcomes were decided from the perspective of the patient as opposed to the funders of dance related healthcare systems, thereby putting greater emphasis on reduction of injuries as opposed to costs of service/resource. Although rated as very low evidence, suggesting that the true effect may be much larger or smaller, there is sufficient call to consider means to reduce the overall injury rate in dancers. The role of comprehensive medical management as a means to address the important patient outcome of Injury Reduction was demonstrated to have a Very Low evidence profile. Using the GRADE framework a strong recommendation for the use of comprehensive medical management for the reduction of injury rate in dancers is advocated in the absence of stronger evidence (Table 5).

The value to this system is that it allows for a strong recommendation to be made despite a lower level of evidence presented. This is through basing the recommendation on patient important outcomes and evaluating the benefit versus harm or that the desirable effects outweigh the undesirable effects in respect to the intervention. The use of comprehensive medical management for professional athletes reflects more a duty of care in modern sports medicine and so fits with a strong recommendation for its implementation in dance in the absence of higher evidence. This study also helps to identify the low level of evidence available supporting the incidence and intervention for dance and dance injuries. Previous international consensus statements in sport have been agreed to improve the methodology for the collection of injury data [65-67]. Within these consensus statements, there is an advocacy towards methodologies that utilise prospective cohort studies with time loss injury definitions and calculated exposure, allowing incidence to be calculated as injuries per 1000hours of sports participation. The process of reaching (and using) consensus definitions has also been recognised in dance [68-70]. There is a need to consider a similar consensus statement for injury data collection in dance to improve methodological rigor and consistency between studies in line with those recommendations in sport.

Limitations

Although this systematic review was conducted using Medline based electronic databases, specialised journals and grey literature, the exclusion of a full PubMed due to the requirement of medical subheadings in the search process, may result in some relevant studies not being identified. The exclusion of unpublished work/thesis, poster presentations and abstracts along with chapters from books may also reduce the total number of studies available from which evidence and recommendations can be drawn. Similarity the exclusion of non-English language studies is a further limitation.

Conclusion

The two previous systematic reviews concluded that the quality of evidence surround musculoskeletal injury and pain in dancers was low. The results of this systematic review were similar when using the GRADE system. Using the GRADE system two patient important outcomes, namely injury rate and injury reduction, were examined across the studies retrieved and an overall rating of evidence for both outcomes was very low. The value of implementing GRADE is the direction and strength of recommendations may differ from the evidence profile if the proposed benefits outweigh any harm. The use of the Evidence to Recommendation Framework enhances the transparency of those recommendations. A recommendation for the use of comprehensive medical management for the reduction of injury rate in dancers is advocated in the absence of stronger evidence. In the absence of an authoritative governing body, we would hope that those organisations involved in training or performances involving dancers would consider this recommendation. In an attempt to improve the methodological rigor in dance injury studies we advocate the development of a consensus statement along the lines achieved in other sports.

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