Incidence and Prevalence of Musculoskeletal Injury in Ballet

A Systematic Review

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Background: Most published studies on injuries in the ballet dancer focus on the lower extremity. The rigors of this activity require special training and care. By understanding prevalence and injury pattern to the musculoskeletal system, targeted prevention and treatment for this population can be developed.

Purpose: To determine the incidence and prevalence of musculoskeletal injuries in ballet.

Study Design: Systematic review; Level of evidence, 4.

Methods: A systematic review registered with PROSPERO was performed using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Level 1 through 4 evidence studies reporting incidence of musculoskeletal injuries in male and female ballet dancers were included, with the numbers and types of injuries extracted from each. Injury rates were recorded and calculated based on professional status, sex, and nature of injury. Incidence was defined as number of injuries sustained over a specific time. Prevalence was defined as proportion of subjects with an injury at a given point in time.

Results: The studies analyzed reported injury incidence or prevalence in more than 1365 amateur and 900 professional dancers. The mean age was 16.2 years among amateur and 27.0 years among professional dancers. The incidence of injury among amateur dancers was 0.99 and 1.09 injuries per 1000 dance hours in males and females, respectively; 75% of injuries were overuse, with similar rates among males and females. In professional dancers, the incidence of injury was 1.06 and 1.46 injuries per 1000 dance hours in males and females, respectively, and 64% of female injuries were overuse, compared with 50% in males ($P < .001$). Only 3 studies provided prevalence data, including 62% prevalence of lumbosacral pain, 58% painful snapping hip, and 29% patellofemoral pain. Lower extremity injuries comprised 66% to 91% of all injuries, with the foot and ankle accounting for 14% to 57%.

Conclusion: The overall incidence of injury among amateur and professional ballet dancers is 0.97 and 1.24 injuries per 1000 dance hours, respectively. The majority are overuse in both amateur and professional dancers, with amateur ballet dancers showing a higher proportion of overuse injuries than professionals ($P < .001$). Male professional dancers show a higher proportion of traumatic injuries, accounting for half of their injuries ($P < .001$).

Keywords: ballet dance injury; musculoskeletal injury; overuse injuries

Ballet, or classical dance, is a popular sport and recreational activity that places extreme physical demands on the human body. Even within the realm of dance, ballet presents unique demands in terms of flexibility and strength, as well as body aesthetics. These demands influence fitness training regimens and nutritional habits.[25,41] Injury patterns in ballet would be expected to be unique, requiring a targeted approach to injury prevention and treatment.[40] Prerequisite to such a targeted treatment approach is an understanding of specific injury patterns among ballet dancers.

Various reviews on dance injuries have been published. These include heterogeneous populations of both ballet and nonballet dancers.[3,13,17,18,28,35,38,39] The majority of ballet injury investigations predominantly report lower extremity injuries.[4,16,24,26,31-34] Less frequently reported injuries include back and upper extremity injuries.[1,3,7] Recently,

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as young adult hip pathology has become better understood and less invasive treatment options have become more widely available, attention has been heightened with respect to injuries of the hip. This is especially pertinent to ballet, given the stresses placed on the hip and pelvis resulting from the extreme motion required in ballet.[19]

The purpose of this study was to perform a systematic review that determined the incidence and prevalence of musculoskeletal injury in ballet. The authors hypothesized that the incidence of injury would be greater than 1 injury per 1000 dance hours, with a 25% overall injury prevalence. Given the rigorous demands of strength and flexibility in ballet, most injuries were expected to affect the lower extremity.

METHODS

Search Strategy

A systematic review was registered with PROSPERO (registration number, CRD42014010088) on June 5, 2014, and performed using PRISMA guidelines (Preferred Reporting Items for Systematic reviews and Meta-Analyses).[22] On June 4, 2014, a PubMed (MEDLINE) search was performed using the following search string: (((((injury[Title/Abstract]) OR injuries[Title/Abstract]) OR pain[Title/Abstract])) AND ((((ballet[Title/Abstract]) OR dance[Title/Abstract]) OR dancer[Title/Abstract]) OR dancing[Title/Abstract]).

Study inclusion criteria included peer-reviewed published therapeutic studies with levels 1 through 4 evidence (Center for Evidence Based Medicine [CEBM] classification) that were written in English from January 1, 1984 to June 4, 2014, to identify studies written in the past 30 years. Diagnostic and prognostic studies reporting incidence or prevalence of musculoskeletal injury in ballet were eligible. Study participants included ballet dancers from all ages, both sexes, and all levels (ie, recreational, competitive, elite amateur, professional). Conference abstracts were not eligible for inclusion. Level 5 evidence, narrative reviews, synthetic reviews (systematic reviews, meta-analyses), letters to the editor, biomechanical studies, anatomical studies, surgical studies, and basic science studies were also excluded. Non–English language investigations were excluded. Articles on other forms of dance, such as modern, hip hop, ballroom, contemporary, jazz, folk, street, Latin, and swing were excluded. Articles including both ballet and nonballet types of dance without separating out ballet injury incidence or prevalence were excluded. Finally, articles based on ballet but not addressing ballet injuries were eliminated. Case series reports focusing only on 1 specific injury in dancers (eg, flexor hallucis longus tendon injury) without injury incidence or prevalence data were excluded. Duplicate patient populations appearing in separate distinct publications were analyzed and only reported once.

Results from the search string above were initially screened based on a review of abstract or full-text of each article. Studies that were clearly irrelevant were removed. The remaining articles were obtained in full-text PDF format and reviewed.

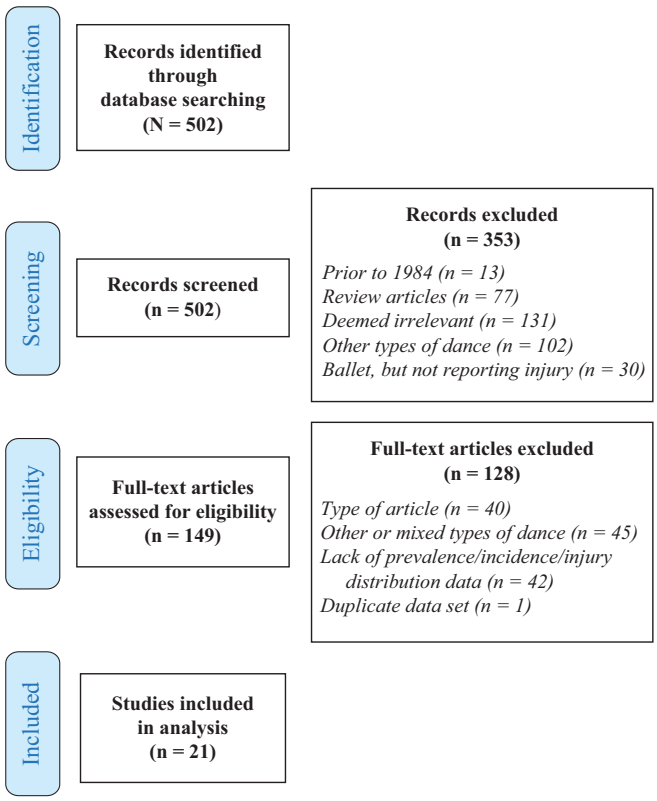

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram developed from this systematic review of 21 studies.

Data Extraction

Data were extracted from each study and recorded in Microsoft Excel. Country of origin, year of publication, journal of publication, author list, amateur or professional status, definition of injury, age, sex, number of participants, number of injured participants, number of injuries, injury incidence, injury prevalence, nature of injuries (ie, acute traumatic vs chronic overuse), and injury sites/diagnoses were recorded.

Definition of Injury

Varied definitions of injury were employed by different authors among these studies. The most common definition, used by 6 studies,[2,4,6,8,29,44] was based on conditions that required at least modification of dance activities, even if no dance activities were missed. A more stringent definition used in 5 studies[5,9,12,23,43] included an element of time lost from activities. Five additional studies[10,11,27,37,42] appeared to fall into one of these first definitions but did not explicitly state whether they included an element of time lost. Three studies[14,20,30] defined injury based on participants having sought care from either an orthopaedic surgeon or a physical therapist. One study[15] based the definition of injury on the incurrence of medical expenses. One study[21] did not include a specific definition of injury.

TABLE 1
Study Demographics[a]

Study (Year)	Country	Conflict of Interest	Level	Age, y, Mean ± SD	Dancers, n	Injured Dancers, n	Injuries, n
Bowerman et al[4] (2014)	Australia	No	Amateur	16 ± 1.58	46 (30 F, 16 M)	29	59
Allen et al[2] (2013)	England	—	Professional	Season 1: 25 ± 5 F, 23 ± 4 M Season 2: 25 ± 5 F, 24 ± 4 M Season 3: 26 ± 5 F, 24 ± 4 M	Season 1: 52 (27 F, 25 M) Season 2: 58 (29 F, 29 M) Season 3: 53 (27 F, 26 M)	—	Season 1: 355 Season 2: 183 Season 3: 174
Drezewska and Sliwinski[11] (2013)	Poland	—	Amateur	16.5	71 (45 F, 26 M)	44 (28 F, 16 M)	—
Ekegren et al[12] (2013)	England	—	Amateur	17.2 ± 1.21	266 (154 F, 112 M)	203 (117 F, 8 M)	378
Wyon et al[44] (2013)	England	No	Professional	26 ± 4.57	24 (13 F,11 M)	12	12
Comin et al[9] (2012)	England	No	Professional	26.4 ± 6.6 F, 28.7 ± 5.8 M	79 (44 F,35 M)	10	14
Campoy et al[8] (2011)	Brazil	No	Not specified	18.3 ± 4.7	258	197	320
Leanderson et al[20] (2011)	Sweden	No	Amateur	—	476 (297 F, 179 M)	210	438
Gamboa et al[14] (2008)	United States	—	Amateur	14.7 ± 1.9	359 (288 F, 71 M)	151	198
Liederbach et al[23] (2008)	United States	No	Amateur and professional	—	117 (64 F,53 M)	—	1427
Winston et al[43] (2007)	Canada	No	Amateur and professional	Amateur: 16.8 Pro: 27.3	87 (57F, 30M); Amateur: 47 Professional: 40	79	—
Negus et al[29] (2005)	Australia	—	Amateur	18	29	29	82
Byhring and Bo[6] (2002)	Norway	—	Professional	26 ± 5.7 F 27 ± 4.6 M	41 (27 F,14 M)	31	64
Coplan[10] (2002)	United States	—	Amateur	22	30 (27 F, 3 M)	14	22
Nilsson et al[30] (2001)	Sweden	—	Professional	28.3	78 average/season (5 seasons)	98	390
Menetrey and Fritschy[27] (1999)	Switzerland	No	Professional	—	60	—	238
Bronner and Brownstein[5] (1997)	United States	—	Professional	—	30 (19 F,11 M)	12	12
Lewis et al[21] (1997)	England	—	Professional	44.2 at time of survey	60	60	—
Winslow and Yoder[42] (1995)	United States	—	Amateur	—	41 F	12 F	13
Ramel and Moritz[37] (1994)	Sweden	—	Professional	27	128	121	—
Garrick and Requa[15] (1993)	United States	—	Professional	—	282	107	309

[a]F, female; M, male.

Statistical Analysis

Chi-square analysis was used to compare the numbers of dancers with overuse verses traumatic injuries among males and females and amateurs versus professionals.

RESULTS

Twenty-one studies were included in the final analysis (Figure 1). No article reported the presence of a financial conflict of interest. Eight articles denied the presence of any conflict of interest. In 13 articles, conflict of interest was simply not addressed. There were more than 1365 amateur and 900 professional dancers analyzed (Table 1). The mean age (±SD) was 16.2 ± 1.02 years among amateur and 27.0 ± 1.08 years among professional dancers.

Distribution of Injuries

Twelve studies[‡] reported distribution of injuries based on body site. Percentages of total injuries per body site either were reported or were calculated from the number of injuries for each site. Due to a lack of a uniform injury site classification scheme across studies, pooling data to calculate

[‡]References 4-6, 8, 10, 12, 14, 15, 20, 23, 29, 30.

TABLE 2
Distribution of Injuries Among Amateur Dancers[a]

Study	Exclusions	Injuries, n	Injury Location		
			Head/UE/Back	LE	Foot and Ankle
Bowerman et al[4]	UE and traumatic	59	Lumbar spine, 7%	93% (hip, 24%; upper leg, 7%; knee, 7%; lower leg, 9%)	46% (ankle, 15%; foot, 31%)
Negus et al[29]	UE	82	Low back, 9.8%	90.2% (hip, 25.6%; thigh, 1.2%; knee, 7.3%; lower leg, 19.5%)	36.6% (ankle, 25.6%; foot, 11.0%)
Coplan[10]	UE and traumatic	22	Low back, 13.6%	86.4% (hip, 4.5%; knee, 36%; shin, 22.7%)	18.1% (ankle, 13.6%; foot, 4.5%)
Ekegren et al[12]		378	Head and neck, 3%; UE, 3% (shoulder, 64% of UE); trunk, 16% (lumbar spine, 60% of trunk)	77% (hip/groin, 7%; thigh, 2%; knee, 10%; lower leg [shin & calf], 17%)	39% (ankle, 24%; foot, 15%; unspecified, 3%)
Leanderson et al[20]		438	UE/misc, 3.9%; back, 13%	83.1% (high/hip, 11%; knee, 21%; foot/lower leg, 52%)	
Gamboa et al[14]		198	Back, 9%	91% (hip, 22%; knee, 16%)	53% (all foot/ankle)

[a]LE, lower extremity; misc, miscellaneous; UE, upper extremity.

TABLE 3
Distribution of Injuries Among Professional or Unspecified Dancers[a]

Study	Level	Injuries, n	Injury Location		
			Head/UE/Back	LE	Foot and Ankle
Byhring and Bo[6]	Professional	64	Neck, 9%; shoulder/arm, 4%; upper back, 11%; low back, 8%	68% (hip, 14%; knee, 16%; leg, 24%)	14% (ankle, 3%; foot, 11%)
Nilsson et al[30]	Professional	390	UE, 7.2%; lower back/gluteal region, 17.9%; misc, 1.9%	71.6% (thigh/groin, 4%; knee, 11%; lower leg, 3%)	54% (foot/ankle, 54%)
Bronner and Brownstein[5]	Professional	12	Cervicothoracic, 0%; lumbopelvis, 34%	66% (thigh, 0%; knee, 8%; calf, 8%)	50% (ankle, 25%; foot, 25%)
Garrick and Requa[15]	Professional	309	Head, 1.0%; C-spine, 4.9%; shoulder, 0.6%; arm, 1.6%; elbow, 0.6%; forearm, 0.3%; wrist, 1.0%; hand/fingers, 4.9%; chest, 1.0%; T-spine, 2.6%; L-spine, 23.0%; pelvis, 0.3%; other, 0.3%	57.9% (hip, 5.8%; thigh, 1.0%; knee, 6.8%; leg, 6.1%)	37.20% (ankle, 13.3%; foot/toes, 23.9%; other, 1.0%)
Campoy et al[8]	Unspecified	320	Upper limbs, 14.37%; trunk/hip, 7.19%	78.44% (thigh/leg, 27.5%; knee, 22.19%)	28.75% (foot/ankle, 28.75%)
Liederbach et al[23]	Mixed	1427	UE, 3%; spine, 12%; other, 13%	72% (hip, 9%; knee, 6%)	57% (foot/ankle, 57%)

[a]C-spine, cervical spine; L-spine, lumbar spine; LE, lower extremity; misc, miscellaneous; T-spine, thoracic spine; UE, upper extremity.

overall percentages for each site was not possible. However, grouping sites into broader categories such as lower extremity (LE) or foot and ankle was possible. In the amateur groups (Table 2), 3 studies excluded upper extremity (UE) injuries. Two of these also excluded traumatic injuries. In these studies excluding UE injuries, LE injuries accounted for 86% to 93% of injuries, with 18% to 46% of total injuries occurring in the foot and ankle. Of those reporting injuries from all body sites, the LE injuries comprised 75% to 91% of total injuries, with foot and ankle accounting for 39% to 53%. In the professional groups and unspecified groups, a similar pattern was seen (Table 3). LE injuries made up 66% to 78% of all injuries, with 14% to 57% of all injuries involving the foot and ankle (Table 4).

TABLE 4
Specific Injury Sites/Injuries Reported in at Least 1 Study

Low Back/Pelvis	Lower Extremity
Spine fracture/stress fracture	Anterior/posterior/medial hip
Lumbar disc herniation/ sciatica	Groin strain/tendinosis groin/groin pull
Low back strain/ lumbago	Hip flexor tendonitis/bursitis
Pelvis fracture	Iliotibial band injury
	Snapping hip
	Hamstring strain
	Lateral thigh
	Chondromalacia patellae/anterior knee/ patellofemoral pain
	Jumper's knee/tendonitis genu/patellar tendinopathy
	Anterior cruciate ligament (ACL) injury
	Knee cartilage injury/medial and lateral meniscal injury
	Anteromedial/posterior/lateral leg
	Tibial stress fracture, tibial tenoperiostitis/ shin splints
	Ankle anterior/posterior impingement/ synovitis/bursitis
	Ankle tendon injury/tendinopathy/ tenosynovitis/Achillodynia
	Tarsal sprain/ankle sprains/ankle fractures
	Anterior/posterior/lateral/medial ankle
	Subtalar subluxation
	Tendinosis pedis/peroneal/flexor hallucis longus/tibialis posterior
	Foot stress reaction/stress fracture/ metatarsal stress fracture
	Foot sprain/fracture/4th metatarsal fracture
	Metatarsalgia
	Retrocalcaneal bursitis
	Calcaneodynia/calcaneal spur
	Plantar fasciitis
	Medial/lateral midfoot
	Medial/lateral forefoot
	Exostosis big toe
	Distorsion dig pedis (Leanderson et al[20])
	Dislocation

Injury Prevalence

Only 3 studies provide prevalence data. Drezewska and Sliwinski[11] reported a prevalence of lumbosacral pain in 62% of 71 dancers, with no significant difference in prevalence between females and males. Winslow and Yoder[42] reported a 29% prevalence of patellofemoral pain in a sample of 41 female ballet students. Winston et al[43] reported on a sample of 87 professional and amateur dancers with a 91% prevalence of snapping hip, of which 58% were painful. However, only 8% of the dancers reported having to take time off from dancing due to pain.

Injury Incidence

Incidence was reported as either a rate of injury per 1000 dance exposures,[4,12,14,23] or more commonly, per 1000 dance hours.[2,4,12,14,20,30,44] Seven studies reported injury incidence per 1000 dance hours, including 4 amateur populations[2,12,14,20] and 3 professional populations.[2,30,44] Among the amateur populations (Table 5), 1147 total dancers (769 female, 378 male) accumulated 1073 injuries (522 in females, 353 in males; some studies did not specify sex) during 1,111,133 total dance hours. This corresponds to 0.97 (range, 0.77-2.40) injuries per 1000 dance hours overall, with 0.99 (range, 0.8-2.19) injuries per 1000 dance hours for females and 1.08 (range, 0.8-2.81) injuries per 1000 dance hours for males. Among the professional populations (Table 6), 577 total dancers (96 female, 91 male, 390 unspecified) accumulated 1114 injuries (538 in females, 576 in males) over 896,942 total dance hours. This corresponds to 1.24 (range, 0.62-4.44) injuries per 1000 dance hours overall, with 1.06 (range, 0.56-4.14) injuries per 1000 hours in females and 1.46 (range, 0.70-4.76) injuries per 1000 dance hours in males. Combining amateur and professional populations (Table 7) results in 1724 total dancers with 2187 total injuries over 2,008,075 hours, or 1.09 injuries per 1000 dance hours. Overall, female and male dancers had rates of 1.03 and 1.29 injuries per 1000 dance hours, respectively.

Injury Characterization

Six studies characterized injuries as traumatic verses overuse, including 2 from professional ballet populations[2,30] and 4 from amateur populations.[12,14,20,29] In the amateur groups (Table 8), 1096 injuries among 975 dancers were reported. Overuse injuries made up 75% (range, 72%-82.9%) of all injuries in this demographic. Only 1 study[20] subdivided injuries based on sex, with overuse injuries comprising approximately 77% of injuries in both males and females. Among professional dancers (Table 9), 1102 injuries among 261 dancers were reported; 57% (range, 56.7%-57.4%) of these injuries were reported as overuse injuries. In this group, injuries in females comprised 64.4% (range, 61.5%-66.3%) of overuse injuries, while overuse injuries in males totaled 50.1% (range, 48.8%-52.7%). When amateur and professional populations were pooled together (Table 10), 2198 injuries among 1236 dancers were predominately overuse injuries, accounting for 65.9% of total injuries. Overuse injuries in females accounted for 68.6% of injuries compared with 56.2% in males.

DISCUSSION

The purpose of this study was to determine the incidence and prevalence of musculoskeletal injury in ballet. As hypothesized, the incidence of injury was high, with most injuries affecting the lower extremity. The incidence of injury among amateur dancers was 0.99 and 1.09 injuries per 1000 dance hours in males and females, respectively. Seventy-five percent of injuries were due to overuse, with similar rates among males and females. In professional dancers, the incidence of injury was 1.06 and 1.46 injuries per 1000 dance hours in males and females, respectively. Sixty-four percent of female injuries were due to overuse,

TABLE 5
Injury Incidence Among Amateur Dancers

Study	Age, y	Study Period	Dancers, n (Female/Male)	Injured Dancers, n	Total Injuries, n	Total Hours	Injury Incidence (per 1000 Dance Hours)		
							Overall	Female	Male
Bowerman et al[4]	16 ± 1.58	6 mo	46 (30/16)	29	59	24,583	2.40	2.19	2.81
Ekegren et al[12]	15-19	1 school year	266 (154/112)	203	378	274,089	1.38	1.36	1.40
Leanderson et al[20]	10-21	7 school years	476 (297/179)	210	438	555,318	0.79	0.8	0.8
	≤10				13	35,333	0.37	0.3	0.5
	11-14				171	258,571	0.66	0.7	0.6
	15-21				254	261,414	0.97	0.9	1.1
Gamboa et al[14]	9-20	5 school years	359; mean, 71.8 per year (288/71)	151	198	257,143	0.77	—	—
Total			1147 (769/378)	593	1073	1,111,133	0.97	0.99	1.08

TABLE 6
Injury Incidence Among Professional Dancers

Study	Study period	Dancers, n (Female/Male)	Injured Dancers, n	Total Injuries, n	Total Hours	Injury Incidence (per 1000 Dance Hours)		
						Overall	Female	Male
Allen et al[2]	3 seasons	163 (83/80)	—	712	255,142	2.79	2.53	3.05
	Year 1	52 (27/25)		355	79,924	4.44	4.14	4.76
	Year 2	58 (29/29)		183	89,146	2.05	1.71	2.40
	Year 3	53 (27/26)		174	86,072	2.02	1.81	2.22
Wyon et al[44]	4 mo	24 (13/11)	13	12	12,768	0.94	1.01	0.85
Nilsson et al[30]	5 seasons	390 (average 78 per season)	98	390	629,032	0.62	0.56	0.70
Total		577 (96/91)		1114	896,942	1.24	1.06	1.46

TABLE 7
Overall Injury Incidence

Injured Dancers, n	Total Injuries, n	Total Hours	Injury Incidence (per 1000 Dance Hours)		
			Overall	Female	Male
1724	2187	2,008,075	1.09	1.03	1.29

while 50% of injuries in males were attributed to overuse. There was a notable paucity of studies reporting prevalence of ballet injuries. Only 3 studies provided prevalence data, including 62% prevalence of lumbosacral pain, 29% prevalence of patellofemoral pain, and 58% prevalence of painful snapping hip. Overall, lower extremity injuries comprised 66% to 91% of all injuries, with foot and ankle accounting for 14% to 57% of these.

Analyzing injury rates or incidence is challenging. Reporting based on injuries per 1000 dance hours or injuries per 1000 dance exposures provides a standardized method of reporting injury rates. Assuming that dance hours or dance exposures both within and among groups of comparison are uniform in intensity, these methods of reporting allow for easy comparison across populations studied for various amounts of calendar weeks, months, or years. In the amateur dancers reviewed here, there were similar rates of injury between males and females: 0.99 and 1.09 injuries per 1000 dance hours, respectively. Injury rates were also noted to rise with increasing age among students. Overuse injuries accounted for the majority of injuries, comprising 75% of all injuries, with similar rates for male and female dancers.

At the professional level, these trends changed. In general, the injury rate increased compared with the amateur level. Males had a higher rate of injury, at 1.46 injuries per 1000 dance hours, while the injury rate in females was little changed, at 1.06. Additionally, the nature of the injuries also changed. Traumatic injuries accounted for more of the overall injuries among professionals. While overuse injuries still accounted for the majority of female injuries at 64%, 50% of injuries in males were traumatic.

Unfortunately, a review of point prevalence of injuries in ballet revealed a surprising paucity of data. Only 3 studies reported prevalence of musculoskeletal injuries or conditions. Being able to understand what injuries exist and the numbers of dancers affected by injury at a given point in

TABLE 8
Nature of Injuries Among Amateur Dancers

			Overall Injuries, n (%)		Female Injuries, n (%)			Male Injuries, n (%)		
Study	Dancers, n	Injuries, n	Traumatic	Overuse	Traumatic	Overuse	Total	Traumatic	Overuse	Total
Ekegren et al[12]	266	378	106 (28.0)	272 (72.0)	—	—		—	—	
Leanderson et al[20]	476	438	101 (23.1)	337 (76.9)	62 (23.0)	207 (77.0)	269	39 (23.1)	130 (76.9)	169
Gamboa et al[14]	204	198	54 (27.3)	144 (72.7)	—	—		—	—	
Negus et al[29]	29	82	14 (17.1)	68 (82.9)	—	—		—	—	
Total	975	1096	275 (25.1)	821 (74.9)	62 (23.0)	207 (77.0)	269	39 (23.1)	130 (76.9)	169

TABLE 9
Nature of Injuries Among Professionals

			Overall Injuries, n (%)		Female Injuries, n (%)			Male Injuries, n (%)		
Study	Dancers, n	Injuries, n	Traumatic	Overuse	Traumatic	Overuse	Total	Traumatic	Overuse	Total
Allen et al[2]	163	712	308 (43.3)	404 (56.7)	109 (33.7)	214 (66.3)	323	199 (51.2)	190 (48.8)	389
Nilsson et al[30]	98	390	166 (42.6)	224 (57.4)	80 (38.5)	128 (61.5)	208	86 (47.3)	96 (52.7)	182
Total	261	1102	474 (43.0)	628 (57.0)	189 (35.6)	342 (64.4)	531	285 (49.9)	286 (50.1)	571

TABLE 10
Overall Traumatic Versus Overuse Injuries

		Overall Injuries, n (%)		Female Injuries, n (%)			Male Injuries, n (%)		
Dancers, n	Injuries, n	Traumatic	Overuse	Traumatic	Overuse	Total	Traumatic	Overuse	Total
1236	2198	749 (34.1)	1449 (65.9)	251 (31.4)	549 (68.6)	800	324 (43.8)	416 (56.2)	740

time would be valuable information, especially for a ballet company. Further quantification based on sex, position, time of season, and so on, would also provide useful guidance for management of the company.

Examining relative distributions of injuries allows for identification of body sites that are most prone to injury and suggests which body sites should be targeted for treatment and prevention efforts to have the most significant impact, whether from a time lost or financial perspective. Reviewing the list of specifically reported injuries across all the articles in this review is also revealing. This may be helpful for identifying further study opportunities for elucidating additional specific injuries in the context of ballet. For example, while snapping hip due to iliopsoas tendinitis/bursitis has been reported, no mention is made of femoroacetabular impingement and associated pathology.

Without a standardized methodology for injury surveillance among ballet dancers, pooling data and making meaningful comparisons among ballet populations to guide injury prevention efforts proves difficult, as highlighted in this review. Key elements of an effective approach would include a consensus definition of injury, a standardized method of reporting exposure and injury incidence, and a uniformly applied injury classification scheme. In these studies, the method of defining injuries varied widely, including need for activity modification, time lost from activity, need for consultation with a health care practitioner, or even incurrence of financial cost. Each of the varied definitions of injury has its nuances, but adoption of a single standard would facilitate reliable comparisons among different populations of dancers. Additionally, while many of the recent studies analyzed here reported injury incidence as injuries per 1000 dance hours, this clearly has not been standardized. Finally, injuries should be classified based on a uniformly adopted classification scheme. One example is the Orchard Sports Injury Classification System (OSICS), which was initially developed in 1992 for injury surveillance in rugby and Australian rules football.[36] Subsequently, it has been revised and expanded for international use in other sports, such as soccer and cricket. Each of these aspects of a standardized approach to injury surveillance would enable pooling of data across studies and populations in ballet, facilitating more efficient and more reliable efforts at injury prevention.

Study limitations include heterogeneity in definitions of injury among the studies analyzed, heterogeneity in methods of reporting injury rates, and heterogeneity in methods of reporting injury sites. As with any systematic

review, the quality of the review is only as good as the data from the individual studies analyzed. For example, some studies employed questionnaires to elicit injury data, inherently prone to recall bias, rather than prospectively collecting injury incidence and prevalence. Further limitations include variability in study design and conduct, subject demographics, level of dance participation, length of follow-up (or time of enrollment for assessment of incidence), and heterogeneity in clinicians making the diagnosis of injury. Furthermore, the lack of any objective short- or long-term assessment, such as plain radiographs or magnetic resonance imaging, precludes analysis of the effect of dancing on the health of the dancer's body. In essence, does the extreme motion and stress placed on the dancer's body have long-term effects on the occurrence of degenerative conditions such as osteoarthritis? This study does not answer that question. However, it does provide an impetus for future research at the authors' institution and other institutions interested in preservation of the health of the ballet dancer.

CONCLUSION

In this review, the overall incidence of injury among amateur and professional dancers was calculated to be 0.97 and 1.24 injuries per 1000 dance hours, respectively. The majority of ballet injuries were due to overuse in both amateur and professional dancers, with amateur ballet dancers showing a slightly higher proportion of overuse injuries than professionals. Male professional dancers showed a relatively higher frequency of traumatic injuries, which account for half of their injuries.

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