The Prevalence of Injury Among Tap Dancers

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Abstract

A literature search revealed no information on the prevalence of tap dance injuries, one of several dance styles involving percussive footwork. We conducted a retrospective survey to determine the rates and patterns of injury among a cohort of experienced tap dancers enrolled in "advanced" or "master" classes at the New York City Tap Festival. Demographic factors, dance/performance, exercise, and injury histories were recorded and analyzed and the injury rate per 1000 dance exposures calculated. Calculated injury rates among the tap dancers were substantially lower than those previously reported for other dance and athlete populations. We conclude that kinetic and kinematic analysis is required to explain the apparent decreased risk of injury among tap dancers. Comparison data may lead to improved strategies for injury prevention in these other areas.

The physical and performance stresses of dance upon musculoskeletal structures of the dancer are similar to those of sports activity. This was recognized in the 1984 Olympic Scientific Congress Proceedings, *The Dancer as Athlete.*[1] Early descriptions of dance injuries emphasized care and treatment.[2] More recent studies have surveyed injury prevalence among ballet,[3,4] aerobic,[5-7] stage show,[8-11] and flamenco[12] dancers. Some have revealed injury incidence and prevalence exceeding those reported for inter-collegiate sports.[13]

Tap dance developed in the melting pot of 19th century America from folk dances brought by Irish, Scottish, and English immigrants and African slaves. These early dancers wore soft shoes or wooden clogs. By the 1920s, metal plates or "taps" were attached to leather-soled shoes to heighten the rhythmic patterns and permit more intricate steps.[14] The essence of tap dancing, in common with clogging, Irish step dancing, and gypsy flamenco, is the emphasis on percussive footwork. The impacts produced may create forces and vibrations injurious to the body. A literature search discovered no information relating to injuries among tap dancers. We report here the prevalence of injuries in a cohort of experienced amateur and professional tap dancers.

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Methods

A dance injury survey was modified for administration to tap dancers, reviewed by several experienced tap dance performers, and offered to advanced and master class participants at the New York City Tap Festival during July 2002. The survey instrument contained four sections inquiring about personal and demographic data, dance and performance history, exercise history, and injury history. Injury was defined as "musculoskeletal episodes resulting in missed dance time." The study was classified as "exempt" under university IRB guidelines. Analysis of class attendance sheets showed that 104 of 220 attendees completed the survey (47%). Survey response items were entered into an SPSS version 10.0 statistical program.

The means and standard deviations were calculated for all interval and ratio data. Information was handled in two separate ways dependent upon data type. General and specific injury prevalence was analyzed by nominal data categories (gender, education, smoking habits, medication use, menstrual regularity, weight maintenance, primary dance training, and performance and training habits) via analysis of

variance. In case of a specific finding, data were further analyzed with a Tukey's post hoc test. Exploratory correlations were calculated for all interval and ratio data (age, height, weight, BMI, percent time dancing, dance and training history, performance and training characteristics, injury prevalence, and specific injury occurrence). Significance was set at $p < 0.05$.

We did not calculate an injury occurrence rate/1000 hours of dance exposure since we were unable to obtain precise figures for hours of participation during the long careers of our study subjects. We estimated the injury occurrence rate/1000 dance exposures for our subjects by averaging their years of dancing by tertiles and multiplying by 40 weeks per year dancing 3.5 times/week (since most of the subjects were either students or teachers). This figure divided by the number of injuries provided an estimate of the injury rate/1000 dance exposures.

Results

Ninety female and 14 male dancers completed the survey. Their demographic and dance descriptive characteristics are shown in Table 1. Their mean age was 34 years (range: 15 to 75 years; SD: 14); they had danced for an average of 21 years (range: 1 to 60 years; SD: 13). They spent an average of 40% of their work or school time performing or teaching including 5 hours/week (SD 6.5) in dance classes. In addition, they devoted an average of 1.5 hours/week (SD 1.75) to strength training and 3.25 hours/week (SD 3.75) to aerobic training. While many had trained in various dance disciplines, 90% indicated that they concentrated on tap dancing. The remainder indicated their primary focus on ballet with significant time allocated to tap dance.

Twenty percent of the subjects reported education at high school level (most of these were still in high school); 55% were college-educated, and 23% had graduate degrees. Five percent were current smokers and 16% former smokers. Among the females, 54% reported regular menses, 18% irregular menses, and 11% absent menses. Most of the subjects with amenorrhea were postmenopausal. Sixteen percent of the women did not indicate their menstrual status. Eight-two percent of the subjects reported that they had no difficulty maintaining their current body weight while 17% reported weight concerns. One subject did not answer this inquiry.

Table 1 Demographic and Dance Descriptive Characteristics of Study Subjects

Characteristic	Males (n = 14) Mean	SD	Females (n = 90) Mean	SD
Age nearest year	34	16	33	14
Height (cm)	177.2	8.4*	163.93	6.7
Weight (kg)	70	6.0*	59.1	8.9
Body mass index (kg/m²)	22.34	1.96	21.98	2.85
Percent of work time dancing	46.2	41.6	42	34.7
Age began dancing	10.3	6.3	10.5	11.9
Total years dancing	22	16.8	20.5	12
Rehearsal time (hrs/wk)	2.6	3.75	2.6	5.3
Number of dance classes per week	4.8	5.6	4.8	6.4
Warm up (min/day)	15.7	19.6	24.2	31.1
Stretching (min/day)	12.5	16.3	20.7	18.4
Aerobic training (hrs/wk)	1.7	1.8	3.5	3.9
Weight training (hrs/wk)	1.6	2.2	1.3	1.7

* Males significantly greater than females, $p < 0.005$.

Forty-one percent of the dancers reported no injury attributable (or possibly attributable) to dance activity. Thirty-four percent reported one injury, 16% two injuries, 4% three injuries, and 3% four injuries. One subject each reported 6 and 7 injuries. Therefore, 35% of the injuries were reported by a subgroup of 8.6% of the subjects surveyed. Analysis of various risk factors in these apparently "injury-prone" subjects (age, years dancing, percent work time dancing, exercise hours/week, daily time warming up and stretching, and tobacco use) revealed no significant differences from the rest of the survey cohort.

The injuries experienced by the tap dancers are detailed in Table 2. The 14 male subjects reported 9 injuries (0.64 injuries/dancer) while the 90 females reported 87 injuries (0.97 injuries/dancer). Joint sprains (foot, ankle, knee, hip, back, and neck) accounted for 50 instances of injury while muscle strains (hamstring and calf) occurred 4 times. There were 11 instances of tendinosis (Achilles and hip) and one each of hip bursitis, patellar tendon sprain, and foot contusion. Together, these relatively minor injuries constituted 71% of the total injuries.

More serious injuries occurred: six fractures (4 traumatic and 3 stress), meniscal tears (3 in two subjects), disc ruptures (2), patellar dislocation (1), anterior cruciate ligament tear (1), and rib cartilage separation (1) comprised 16% of reported injuries. Altogether, traumatic episodes produced approximately 75% of injuries among our subjects. The rest included overuse syndromes ("shin splints," stress fractures, Morton neuroma, compartment syndrome, bursitis, and tendinosis).

Since many of the reported injuries occurred at very low frequency, significant correlation coefficients could not be calculated for them. Correlations noted included: 1. a greater frequency of Achilles tendinosis in females compared to males ($p = 0.007$) and 2. a greater frequency of ankle sprains ($p = 0.039$), hip tendinosis ($p = 0.045$), and total number of injuries ($p =$

Table 2 Injury Patterns: Total Number of Injuries

Injury	Males (n = 14)	Females (n = 90)
Cervical	0 (0%)	1 (1%)
Sprain	0	1
Back	2 (2%)	14 (13%)
Lumbar disc rupture	1	1
Sprain	1	13 (2 in one subject)
Hip	0 (0%)	9 (9%)
Sprain	0	4
Tendinosis	0	4
Bursitis	0	1
Thigh	0 (0%)	3 (3%)
Hamstring strain	0	3
Knee	3 (3%)	15 (14%)
Sprain	1	8 (2 in one subject)
Fracture*	1	0
Meniscal tear	1	3 (2 in one subject)
ACL tear	0	1
Patella tendinosis	0	1
Osgood-Schlatter syndrome	0	1
Patella dislocation	0	1
Leg	0 (0%)	5 (5%)
Compartment syndrome	0	1
Calf muscle strain	0	1
"Shin Splints"	0	3
Ankle	4 (4%)	27 (26%)
Sprain	3	19-3 in one subject 2 in four subjects
Fracture	1	0
Stress fracture	0	1
Achilles tendinosis	0	7
Foot	0 (0%)	10 (10%)
Sprain	0	4
Contusion	0	1
Stress fracture	0	2
Morton neuroma	0	3 (2 in one subject)
Other	0 (0%)	3 (3%)
Wrist fracture	0	2
Rib cartilage separation	0	1
Total	9	87

* Clinical details not known by subject.

0.019) in regular exercisers compared to non-regular exercisers. Calculated injury rates/1000 dance exposures were 0.21 for males and 0.34 for females.

Discussion

Prior dance injury studies have usually been retrospective surveys. They used varying definitions of injury, differing time periods of observation, and non-standardized terminology when reporting injury incidence or occurrence rate. For these reasons, their results are difficult to compare to each other and to our study.

Nilsson and colleagues[3] and Garrick and Requa[4] studied professional ballet dancers. Nilsson reported a mean of 3.8 injuries/dancer during a five-year observational period with a calculated occurrence rate of 0.62 injuries/1000 hours of dance activity. Foot and ankle injuries comprised 54% of the total.[3] Garrick and Requa followed a large ballet company for three years reporting 2.97 injuries/dancer during this time. Foot and ankle injuries accounted for 37% of total injuries reported. Injury occurrence rates were not included.[4]

Aerobic dance participants were studied by Rothenberger and associates,[5] Janis,[6] and duToit and Smith.[7] Rothenberger and coworkers surveyed 726 aerobics dancers from four health facilities. Eighty-four percent were females averaging 195 minutes of aerobic activity per week. A total of 843 injuries were reported with "strains" accounting for 21.5%, "tendonitis" for 18%, and "shin splints" for 15.5% of diagnoses. Injury rates could not be determined from the reported data.[5] The report by Janis involved 375 aerobics dancers with an average of 75 weeks (males) to 129 weeks (females) of participation in aerobics. Exposure time and the total injury occurrence rate could not be calculated from the data. Thirty-five percent of the participants reported injury, more frequently in "high impact" (38%) than "low impact" (24%) activity. Seventy-three percent of the injuries occurred at the knee and below. Injury rates ranged from 14% among participants 15 to 20 years old to 63% in the 50 to 55-year-old age group.[6] duToit and Smith found a 77% injury rate among Australian aerobics instructors with leg, foot, and ankle being the most frequently injured sites.[7]

Surveys of stage show performers in America[8] and England[9] have reported 5.1 injuries/1000 performances (8.4 injuries/1000 hours performing) for dancers and 2.4 injuries/1000 performances (2.1 injuries/1000 hours performing) for actors and dancers combined. Knee, ankle, foot, and lower back injuries were most frequent. Bronner and Brownstein[10] described dance injuries in Broadway show performers using "ballet technique." Defining injury as "time lost from performing," they reported an overall injury rate of 40%, with the foot and ankle the most commonly traumatized sites. In another study, Bronner and colleagues[11] followed 42 members of a professional modern dance company for five years while demonstrating the effectiveness of a comprehensive injury management program. The incidence of new in-

Table 3 Injury Occurrence Rate by Tertile of Dance Experience Among the Study Cohort

Number of Subjects	Mean Number of Years dancing (SD)	Calculated injury occurrence rate/1000 dance exposures
35	9.4 (3.9)	0.37
35	17.6 (2.3)	0.42
34	35.4 (10.5)	0.26

juries decreased from 81% to 17% during this time. Injury rates fell from 18.3 to 6.8/1000 dance hours.

Pedersen and Wilmerding[12] surveyed student and professional flamenco dance performers. Foot, ankle, knee, and low back injuries were reported most frequently; half of the injuries were either "current" or "chronic." Injury occurrence rates could not be calculated from their data.

Allowing for varying definitions of injury, periods of observation, and reporting terminology, one may summarize these studies as showing that dance injuries predominantly occur in the lower extremity and lumbar spine. Minor trauma and overuse disorders account for the majority of episodes. Injury incidence per year varies from 24% to 81%, and injury occurrence rates range from 0.62 to 18.3/1000 hours of dance exposure. Comparable injury rates have been reported in various sports.[15,16] The National Collegiate Athletic Association (NCAA®) injury surveillance data reveal sport injury rates ranging from 3.9 to 36.9/1000 athletic exposures.[13]

In contrast, injury rates among our survey subjects were only 5% to 50% of those reported in the studies we have reviewed. Potential explanations for this low occurrence rate include recall bias, the use of an estimate for dance exposures, subject gender mix, non-specific definition of injury in many of the studies, unique characteristics of our subject cohort, and the intrinsic characteristics of tap dance.

Our survey was retrospective and involved self-reports from dancers over a period ranging from 1 to 60 years (average: 21 ± 16 SD). It is certainly possible that in many instances injury episodes may have been forgotten. To explore this possibility, we divided our cohort into tertiles by time dancing and calculated reported injury occurrence rates/1000 dance exposures. The results are shown in Table 3. This reveals a lower injury occurrence rate in the most experienced group. Although this finding supports the presumption of recall bias, the magnitude of this effect seems inadequate to explain the low injury occurrence rate in the entire cohort. For instance, doubling the injury occurrence rate in our most experienced group would only increase the overall cohort injury occurrence rate from 0.31 to 0.45/1000 dance exposures.

In addition, we deliberately estimated a conservative dance exposure rate of 3.5/week, a low figure that, if anything, should have increased our calculated injury rate rather than distorting it downward. Finally, our survey inquired about injuries in general and then specifically queried the most common orthopaedic injuries, requiring subjects to deny their occurrence.

Cohort gender composition is important in comparing injury rates since women may be more prone to certain athletic injuries.[17] A predominantly male population might therefore have reported fewer injuries. Our subjects however were 85% female which, if female gender correlates with injury, should have inflated the injury rate.

We defined injury in our survey as "musculoskeletal episodes leading to time lost from dance." Self-reported injuries may include minor aches that could allow dance activity to continue. If commonly reported, such episodes would inflate injury rates, whereas the more stringent definition that we have used would tend to reduce injury rates. Many of the studies that we have summarized did not specifically define "injury" or used different definitions. For example, Bronner and colleagues[11] defined injury as "musculoskeletal insult resulting in financial outlay." We therefore cannot precisely estimate the effect of varying definitions of injury upon the results that we have reported.

The demographic characteristics of our study subjects (age, years dancing, height, weight, and BMI) do not differ significantly from those reported in several of the studies that we have reviewed.[5,8,12] By contrast, our participants were older with longer experience dancing than the subjects of Bronner and Brownstein[10] and Bronner and colleagues,[11] and certainly older than the athletes included in the NCAA injury surveillance survey.[13] Since one might expect injury incidence to increase with age and time of exposure to activity, we do not believe that unique characteristics of our subject cohort contributed to the low injury rates that we observed. In addition, injury rate in our cohort correlated with regular physical activity. Therefore, poor physical conditioning did not appear to be a factor. Although a greater exposure to exercise in addition to dance activity might have caused some of the injuries reported by our respondents, this factor could not contribute to the lower injury rate that we observed. In agreement with most of the prior studies, the lower extremity and back were the most frequently injured sites reported by our subjects. None of the three female subjects with stress fractures reported any concerns with body weight.

The unique characteristics of tap dance that might influence injury occurrence rates have not been studied. Noble and Howley[18] found that beginning and intermediate tap

dance students had VO_2 of 17 $ml \cdot kg^{-1} \cdot min^{-1}$ during a standard dance routine at a cadence of 112 beats/minute. This is comparable to reported values for "dance activity" of 15.75 to 17.5 $ml \cdot kg^{-1} \cdot min^{-1}$.[19] Noble and Howley suggested however that highly skilled tap dancers would probably have an increased energy requirement for specific tap routines.[18] We have not found any kinetic or kinematic studies of tap dancers that would permit calculation of forces applied while dancing to the anatomic sites that they report to be most commonly injured. We are currently engaged in such a study.

Conclusions

We have found an apparent lower injury occurrence rate in tap dancers compared to other dance and athletic activity. Limitations of our study include those implicit in a retrospective survey, difficulties of comparison with other studies, and the necessity for averaging the estimates of dance exposures for our cohort. In addition, we do not know the magnitude of selection bias introduced by the 47% response rate that we experienced. We believe that additional basic research using kinetic and kinematic data is required to explain our findings, and perhaps, to provide insight into injury prevention in other dance and sport activities.

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