

Original Research

Exploring Trends between Dance Experience, Athletic Participation, and Injury History

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Keywords: dance, deliberate practice, early specialization, injury, overuse

<https://doi.org/10.26603/001c.129805>

International Journal of Sports Physical Therapy

Vol. 20, Issue 3, 2025

Background and Purpose

Dancers sustain substantial injury rates ranging from 0.62-5.6 injuries per 1000 dance exposure hours with 72% of these injuries attributed to overuse mechanisms. Highly technical activities like dance often require high training volumes incorporating deliberate practice from a young age which may contribute to these high percentages of overuse injuries. The purpose of this study was to determine trends between dance participation, athletic participation, and injury history.

Study Design

Cross-sectional survey.

Methods

Dancers over 18 years old with at least one year of dance experience were recruited from across the United States to complete a survey via Qualtrics. The survey included five sections addressing basic demographic information, dance experience, athletic activity history, and injury history. Relationships between variables were analyzed using the Mann-Whitney U test or the Wilcoxon Signed Rank test. Factorial ANOVAs were also used to observe relationships between three or more groups.

Results

Of 424 total responses, 339 were deemed complete for analysis. Nearly 75% of respondents reported experiencing at least one injury that inhibited their dance ability. Greater total injuries were reported by participants who had more years of dance experience, those who practiced ballet, and individuals who began dance before age 12. Approximately one-third of participants exclusively participated in dance with no involvement with other athletic activities. Respondents starting dance prior to age 12 reported participation in fewer athletic activities. However, no difference in the number of injuries was observed between individuals involved in athletic activity compared to those practicing dance alone.

Conclusion

Increased dance exposure and associated high training volumes and repetitive movements may represent a greater risk for overuse injuries than sport specialization in dancers.

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Level of Evidence

3B

INTRODUCTION

Musculoskeletal injuries often have significant impacts on dancers, diminishing performance, predisposing to later injuries and conditions, leading to early retirement, or ending careers. However, there continues to be limited research in this area.¹ Available research is inconsistent in injury definitions and primarily focuses on ballet populations, making it difficult to compare research and draw conclusions.¹⁻⁵ Current research shows a broad range of injury incidence rates from 0.62 to 5.6 per 1000 dance exposure hours.⁶⁻⁸ Of these injuries, overuse injuries are the most common, accounting for around 75% of total injuries.^{9,10} As much of this research is based on a few select dance genres with similar injury patterns, future research is recommended to include a broader variety of styles and techniques to understand overall injury patterns in dance.¹

Sport specialization, the practice of training in a singular sport for the majority of the year at the exclusion of other sports, is a growing trend among young athletes as well as dancers.^{11,12} Though there are some benefits to specializing in sport before age 12, early specialization may have negative effects on athletes' overall performance, resulting in higher likelihood of burnout, overtraining, and injury.^{11, 13} Studies examining youth athletes have shown individuals specializing in a sport at younger ages had increased rates of overuse injury compared to those practicing multiple sports.^{11,13} The underlying cause of many of these injuries seems to be the repetitive actions practiced at high volumes over long durations with minimal rest periods.^{12, 14,15} These approaches are central to early specialization which may contribute to the relationships described between early specialization and injury rates.

Despite the negative outcomes of practicing a single sport, many populations with high technical requirements take advantage of early specialization, often committing to full-time training by age 15.^{10,16} These populations emphasize technical skills and aesthetic, which are thought to require early specialization and high training volumes to improve skill acquisition.^{15,17} One study observing percentages of specialized athletes and incidence of serious overuse injury determined dance, gymnastics, and tennis as leading activities in both categories.¹¹ The same article identified dancers to be ranked second for the youngest age of specialization, preceded only by gymnastics.¹¹ The importance of factors including flexibility and lean body type to the aesthetic of many dance styles, namely ballet, leads individuals to strive to achieve these factors prior to full physical maturation.^{13,18} The increased rates of early specialization in dance may be a potential risk factor for the high incidence of overuse injury (72%), compared to lower incidences reported in traditional sports (15-63%).¹⁰

Like ballet dancers, gymnasts have demonstrated analogous skill sets as well as elements of high training volumes and rates of early specialization. Gymnastics participation often begins around age 7 with specialization encouraged

at 9 or 10 years of age.^{19,20} Gymnasts are reported to practice 12 months out of the year, ranging from 8-36 hours per week depending on their competitive level.^{20,21} Year-round training allows for new skills to be practiced during the off-season, but limits opportunity to introduce other activities or skill diversification.²⁰

Early specialization promotes skill achievement within the necessary timeframes believed to allow for optimal performance. Introducing training by age 7 allows for development of flexibility from ages 7-11, to begin deliberate practice by age 10, and improve power and strength from 12-17.¹⁹ Current literature indicates that although early specialization is often encouraged in gymnasts, it has not been shown to improve performance in this population.²⁰ Recommendations highlight adhering to available guidelines: implementing age appropriate training volumes and encouraging realistic rest periods.²⁰

Deliberate practice aims to gradually improve performance through repetitive practice and feedback to attain elite performance and is commonly implemented in highly technical sports.²² Incremental improvements practiced consistently over time with individualized feedback allow for development and refinement of technical skills to achieve more difficult skills at younger ages.^{14,20} High repetitions of skills in substantial volumes is theorized to develop and perfect the control of these movements.^{14,15} This principle is often applied in highly-specialized activities requiring techniques specific to performance needs.¹⁴ These activities including ballet, figure skating, and gymnastics, also often implement early specialization due to the emphasis of achieving peak performance prior to full physical maturation.^{22,23} These activities often have similar focuses to dance to achieve a certain aesthetic and require skills focusing on flexibility, leg strength, endurance, coordination, agility, and balance.¹⁹

Overtraining has been self-reportedly one of the leading causes of injury in dancers.²⁴ Specialized athletes train at a volume nearly two times greater than their multisport counterparts which has been shown as a greater indicator of injury risk compared to variation of sport participation.¹³ Similar to many athletes specializing in traditional sports, dancers also practice nearly year round, limiting rest periods.²⁵ Many professional dancers practice four to eight hours per day during rehearsal periods. During performance periods, dancers often endure 10 hour days performing eight shows per week on average.^{26,27} Time commitments of professional dancers have been reported as high as 60 hours per week for full-time professionals.²⁸

A number of studies have described the correlation between training load and injury in dancers.²⁹ These high training volumes and minimal rest periods result in around 72% of total dance injuries attributed to overuse.^{10,30} Studies observing weekly dance exposure and overuse injury rate have shown a positive relationship.²⁶ In addition to the significant workload as seen in other sports, the inconsistency in workload may contribute to the increased concern

of overtraining and overuse injuries in dance.²⁶ Lack of balance between training and rest has been shown to result in overreaching, overtraining, burnout, and injury in a number of sports.^{26,31,32} Therefore, the purpose of this study was to determine trends between dance participation, athletic participation, and injury history.

METHODS

SUBJECTS

Current and former dancers throughout the United States were invited to participate in this survey. Inclusion criteria included individuals who have participated in any style of dance for at least one year and must be over 18 years of age at the time of completing the survey. Dancers were recruited via social media and email from programs, companies, teams, and other groups in the dance community. This study was approved by the University of Central Florida Institutional Review Board and informed consent was provided by all participants.

INSTRUMENTATION

This survey was conducted online through Qualtrics. The first page of the survey included the informed consent form where respondents had the option to select “yes” to consent and begin the survey or “no” resulting in automatic dismissal from the survey. The survey consisted of five sections including basic demographic information, dance experience, athletic activity history, and injury history. The entirety of the survey was completed individually by respondents on their own device with no supervision by the study team. Respondents were able to access the survey during a four-week period from October through November 2023.

Dance experience included questions on current dance status, total years of dance participation, style of dance and corresponding amount of time spent practicing each style, and current dance setting. Respondents were also asked to report average weekly hours of ballet technique and conditioning non-specific to dance over the past year. The athletic history section asked respondents to “provide information on your [participant’s] participation in up to three non-dance related athletic activities or sports” along with individual’s level of participation, referring to number of years and average hours per week. Participants were provided an open response question to include their activity or sport and a dropdown to select years and average weekly hours of participation. Lack of specification of criteria defining “non-dance related activities or sports” allowed for varying responses dependent on participant interpretation of this section.

Respondents were asked whether the respondent had “ever had a dance-related injury that rendered you [the participant] unable to practice” which prompted the respondent to report up to five injuries that had the greatest impact on their dance participation. This section allowed individuals to include their self-reported injury description,

month and year of injury occurrence, injury duration, separate Likert scales for initial and current pain rating, and a hot spot map to indicate injury location. It is important to consider that responses were subject to varying interpretation of the question by participants and all injuries were self-reported by participants and not assumed to be medically diagnosed injuries.

STATISTICAL ANALYSIS

Statistical analysis was conducted using IBM SPSS software. Descriptive values of variables were characterized using the mean values and standard deviations. Normality of variable distribution was analyzed using the Shapiro-Wilk test. Relationships between nonparametric variables were analyzed using the Mann-Whitney U test or Wilcoxon Signed Rank test for between groups and within groups tests respectively. Factorial ANOVAs were also used to observe relationships between 3 or more groups. Significance was set to $p \leq 0.05$ with a confidence interval of 95%. Responses considered incomplete or missing data were not included for statistical analysis.

RESULTS

PARTICIPANTS

A total of 424 individuals responded to this survey, with 339 considered complete and included in analysis. Complete responses were those that included complete demographic information, at least one style of dance, and indicated whether or not they had sustained an injury. Of these 339 responses (females=315, males=13, non-binary=11), participants reported an average of 14.35 ± 5.09 years of dance.

ACTIVITY CHARACTERISTICS

A total of 31 dance styles were reported with the average dancer participating in 5.12 ± 2.25 styles. The most frequently mentioned styles included ballet, jazz, hip hop, tap, and modern, respectively. Over two-thirds (232) of participants indicated involvement in athletic activities aside from dance, collectively listing over 20 different sports (Tables 1 & 2).

INJURY CHARACTERISTICS

A total of 414 injuries were reported, involving 252 (74.3%) respondents who reported sustaining at least one injury that prevented them from dancing. The self-reported duration per injury ranged from 1-414 days, with an average duration for the entire sample of 79 days. Ankle injuries were the most frequently reported (10.8%), followed by the knee (7.4%), then back or spine (4.3%).

Table 1. Reported Dance Style Frequencies

Dance style	Number of respondents reporting participation
Ballet (& pointe)	332
Jazz	270
Hip hop (& breaking)	201
Tap	190
Modern (Graham & Horton)	172
Contemporary	164
Lyrical	81
Pom	68
Acro and tumbling	43
Musical theater	43
Latin (Salsa, Bachata, Tango, Kizomba)	19
Ballroom	17
Indian (Bharatanatyam, Bhangra, Bollywood, Kathak, Kuchipudi)	16
Improvisation	8
Clogging	5
Drill team	4
Kick line	4
Other*	57

*Styles reported by <4 respondents

RELATIONSHIP BETWEEN DANCE EXPOSURE AND INJURY

Dancers who reported more years of dance experience (14.39 ± 5.05) also reported more injuries (1.25 ± 1.18) ($t=48.015$, $d=2.612$, $p<0.001$). Due to unique aesthetic and training factors associated with ballet, individuals reporting involvement in ballet were isolated for portions of this statistical analysis. Those who practiced ballet (1.36 ± 1.20) reported a greater total number of injuries than those who practiced all other styles (0.69 ± 0.87) ($t(336)=3.938$, $d=1.159$, $p<0.001$). Similarly, increases in injury duration (77.37 ± 84.89 days) were also reported by individuals who indicated increased average weekly hours of ballet technique (3.89 ± 4.17 hours) ($t(199)=-12.346$, $d=-0.873$, $p<0.001$). No difference in reported injuries was observed between individuals who reported participation in athletic activity in combination with dance compared to dance alone ($t(335)=0.523$, $d=1.187$, $p=0.463$).

PATTERNS IN EARLY DANCE PARTICIPATION

Dancers who began dancing at a younger age reported more total years of dance experience ($p<0.001$) and participation in fewer athletic activities ($p<0.001$). Approximately one-third (107) of participants reported participating exclusively in dance with no other athletic activity throughout their lives. Several significant differences were observed be-

Table 2. Reported Athletic Activity Frequencies

Athletic Activity	Number of respondents reporting participation
Soccer	65
Track/Cross country	65
Cheerleading	30
Gymnastics	29
Basketball	27
Swimming/Diving	27
Volleyball	26
Softball	23
Weightlifting	20
Tennis	17
Martial arts (Brazilian Jiu-Jitsu, Karate, Taekwondo, Wrestling)	13
Lacrosse	7
Pilates	7
Ice skating/Figure skating	6
Baseball	5
Color guard	5
Field hockey	5
Other*	37

*Activities reported by <5 respondents

tween individuals who started dance before age 12 compared to those who started after. Those who started dance before age 12 reported more total injuries (1.31 ± 1.18) than those who began after age 12 (1.02 ± 1.20) ($t(336)=-1.799$, $d=1.180$, $p=0.028$). Individuals starting dance prior to age 12 (1.20 ± 1.09) also reported less total athletic activities compared to those who started later (1.63 ± 1.01), ($t(336)=2.918$, $d=1.076$, $p=0.003$). Greater average weekly hours of ballet technique were also exhibited in dancers who started their participation at earlier ages than those who started after age 12 ($t(296)=-3.269$, $d=4.026$, $p=0.01$). However, there was no significant difference in reported injury rate between those who participated in sports in addition to dance compared to those who practiced dance alone ($t(335)=0.523$, $d=1.187$, $p=0.463$).

INJURY TREND RELATIONSHIPS WITH STARTING AGE OF DANCE AND ATHLETIC ACTIVITY PARTICIPATION

Trends in total injuries reported based on starting age of dance differed between individuals who reported participating in athletic activity and those who participated in dance alone. Those who participated in dance alone showed consistent increases in injury with decreases in starting age from 0-3, (1.74 ± 1.46), 4-7 ($1.15 \pm SD=1.14$), 8-12 (0.94 ± 0.94), and after age 12 (0.50 ± 0.85). Those who participated in at least one athletic activity reported more consistent rates of total injuries regardless of starting age from 0-3, (1.24 ± 1.07), 4-7 (1.31 ± 1.11), 8-12 (1.42 ± 1.28), and after age 12 (1.11 ± 1.25), $p=0.073$.

Table 3. Participation and Injury Patterns by Age of Dance Onset

Age of Dance Onset	Total Injuries	Total athletic activities	Average weekly hours of ballet technique
Before age 12	1.31±1.18*	1.20±1.09*	3.94±4.23*
After age 12	1.02±1.20*	1.63±1.01*	2.39±2.75*

* Statistically significant difference at $p < 0.05$

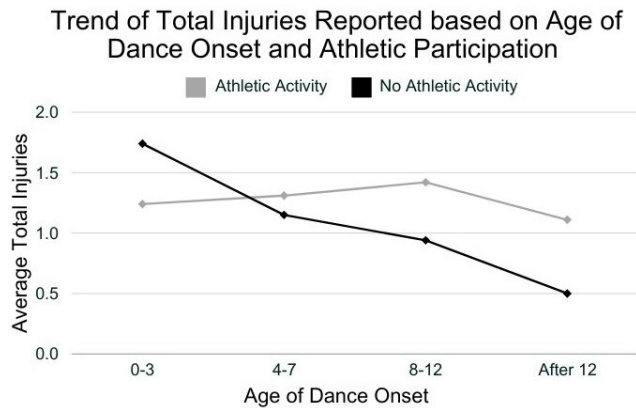


Figure 1. Total injuries reported by dancers based on age of dance onset and athletic activity status

DISCUSSION

The purpose of this study was to examine relationships between dance experience, athletic activity, and injury history using a self-reported survey. Increased injury rates were observed in individuals who reported more years of dance experience, ballet participation, and those who began dance before age 12. Increased average weekly hours of ballet exposure was also related to increased injury duration.

Available literature on ballet populations have reported injury rates ranging from 67-95%, similar to the 74.3% of respondents reporting history of injury in the present survey.³³ Injury patterns collected in this survey closely reflected those available in current literature, with the most commonly reported injuries at the ankle, lower extremity, and low back.^{28,34,35} Ballet technique has consistently been reported to have greater injury rates than all other dance styles.⁷ This is likely a result of the extensive technical demands of ballet requiring high movement repetitions, causing micro-traumas which account for 64% of lower extremity overuse injuries.⁷ These repetitive movements often involve mechanics that are not common to functional movements including end-range external rotation at the hip and end-range plantar flexion at the ankle, and compensations that result from these mechanics.³⁶ This technique places stress on tendons, muscles, bones and ligaments, resulting in injury.⁷ These qualities that distinguish injury risk of ballet dancers from dancers of other styles indicated need for separate analysis. As supported by previous literature, survey findings indicated an increased number of reported injuries by individuals who reported ballet experience compared to those who did not practice ballet.

Increased training duration and dance exposure has been associated with greater risk of injury in dancers.^{2,7,15,23} High volumes of training in combination with repetitive motor patterns and deliberate practice indicate potential cause of overuse injuries in highly specialized populations.³⁷ Monotonic relationships have been observed between years of participation and practice time in a variety of sports including figure skating, karate, and dart players.¹⁴ This trend may also play a role in the positive relationship between years of dance experience and total injuries reported in the present study as those with more experience likely had greater exposure. Comparable findings have been presented in other studies indicating coinciding trends between increased demands of more years of dance training and injury rates.¹⁰ Positive relationships have also been examined between average weekly hours of sport participation and lower extremity injury.¹³ Although no relationship was observed between average weekly hours of dance and injury rate in the present study, a positive relationship was also observed between injury severity, as determined by time-loss, and average weekly hours of ballet technique. Available research suggests reduced repetitive movements and extreme ranges of motion may show decreases in overuse injuries in dancers.³⁸

Sport specialization is most commonly referred to as "participation in a single sport at the exclusion of other sports".^{37,39} Rates of specialization have been reported across youth athletes of all sports ranging from 13-41% similar to that of the current study (31.6%).^{37,40} Sport specialization is classified as either early or late specialization depending on the age an individual begins specializing. Early specialization is reported to begin as early as 6 years old, with 12 years of age being the cutoff before being considered late specialization.^{17,41} Three common criteria are used to define early sports specialization including: intensive training more than 8 months out of the year, participation in only 1 sport, and beginning before age 12.⁴¹

The current study demonstrated dancers beginning dance before age 12 reported lower numbers of athletic activities, indicating earlier starting ages may be related to specialization. Of the individuals who reported dance specialization, 25% began between the ages of 0-3, 49% began between the ages of 4-7, 17% began between the ages of 8-12, and 9% began after age 12. Dancers beginning dance before age 12 also reported lower numbers of athletic activities but increased average weekly hours of ballet exposure.

Existing research shows intense early specialization places athletes at greater risk of injury, burnout, loss of playing time, and early retirement.^{15,17} Although individuals who began dance prior to age 12 reported greater numbers of injuries, and trends indicated increased injury rates

with early dance specialization, no difference in total reported injuries was determined between those who specialized in dance and those who participated in other activities. These findings support the speculation that the concern of high training volumes and repetitive loads to be the driving factor of overuse injuries as opposed to sport specialization.¹⁸ As specialized athletes are characterized by their high training volumes, limited rest periods, and lack of diverse skills indicating high movement repetitions, it can be inferred that the principles behind specialization may be the primary cause of these overuse injuries rather than specialization itself. This is well represented by the findings of this survey indicating no difference in injury rates between those who specialized and those who did not, while those who had increased exposure to dance and particularly ballet did have a greater increase in injury rate.

IMPLICATIONS FOR PRACTICE

Conflicting research emphasizes both benefits of early specialization specific to skill development in dance populations as well as importance of diversifying athletes to mitigate potential for injury and burnout. Current recommendations indicate benefits of delaying sport specialization to late adolescence.^{17,42} Athletes should be encouraged to participate in multiple sports to build a variety of skills through early diversification and promote foundational tasks to succeed during late specialization.¹⁷ Single sporting activities should be limited to a maximum of five days of practice per week and two to three months of rest per year for each individual sport, with at least one day of rest per week from all organized activities.¹² Promoting rest will prevent overuse, fatigue, and burnout to allow time to reduce injuries and encourage mental health.¹²

Recent literature has begun to explore potential for cross-training and conditioning programs for dance populations indicating both performance and injury prevention benefits.³³ Early intervention and implementation of injury prevention methods may reduce physical injury, psychological burden, and improve career longevity.^{10,43} Introduction of cross-training in dance populations is often met with apprehension in fear of resulting in more muscular body types that do not adhere to the typically desired aesthetic. However, current literature applying cross-training in dancers has shown enhanced performance, power, endurance, aerobic fitness and improved injury prevention with no aesthetic consequence, benefitting overall performance.^{44,45} Considering the present concern of preexisting high training volumes, cross-training should be performed in place of rehearsal time rather than in addition to.⁴⁶ Implementation of strength and conditioning exercise into a dancer's routine encourages more diverse skills and assists to mitigate repetitive stresses causing overuse injury.⁴⁶ Available literature acknowledges the importance of implementing dance-specific movements into these cross-training programs.¹⁵ Development of these specialized programs allows for improved adherence to dancers' needs including increased range of motion that is not exhibited in traditional strength training.¹⁵

Periodization in combination with cross-training has potential for optimal injury prevention if applied correctly. While periodization is commonly applied in traditional sports, the inconsistency and uncertainty of seasons within a dancer's schedule causes difficulties during programming.¹⁵ Many studies on traditional sports emphasize the importance of proper planning of training and periodization.^{31,32} Recommendations for the American Academy of Pediatrics Council on Sports Medicine and Fitness recommend practicing a single sport for a maximum of five days per week with one day of rest from all organized activity, and two to three months off per year of each sport.¹² Program development should be intentional when scheduling practice volumes as rapid increases in training load have been linked to increased injury rate in traditional sport populations.³² Collaboration between instructors and the sports medicine team is essential when developing a dance-specific training plan in order to provide a wholistic view on a realistic program.¹⁵

LIMITATIONS

This study faces several limitations. Congruent with many studies involving self-reported data, there is a significant likelihood of inaccuracies in participant responses. The main area of concern being recall bias and self-reporting of injuries. Inadequate healthcare access in combination with general reluctance to report injuries within this population and difficulty recalling past injuries reduces likelihood of reliable injury reporting. These drawbacks caused difficulty in accurately classifying injuries and determining severity. In addition to recall bias, participants were restricted in the amount of dance styles, athletic activities, and injuries that could be included. Though most participants did not require all available fields in the survey, allowing additional space may have improved responses. Along with these concerns, survey questions were phrased to accommodate for a broad range of participants and may have been interpreted differently depending on respondent perspective. Taking this concern into account, future studies may consider including more specific questions to directly observe these discrepancies.

Additionally, determination of early specialization status was calculated based on the reported total years of dance subtracted from the participant's age. Although most participants reported they were currently dancing, indicating these classifications were likely accurate, true starting age was not determined by the questionnaire. The study was also unable to differentiate between individuals who had specialized in dance at one point in time regardless of other activity participation during their life. Finally, respondents had a variety of backgrounds with overlapping qualities. While this significant number of responses were received, defining individuals by a single dance style or dance setting would not accurately represent their dance experience in its entirety. As a significant amount of available literature focuses on professional ballet dancers, ballet was the only style isolated for statistical analysis.

CONCLUSION

The results of this study indicate that high training volumes and years of dance experience seem to be the primary contributing factors to injuries reported in this population. No differences in reported injuries were observed between individuals who practice dance alone to those who practice dance in combination with other athletic activity. However, there were increased injury rates reported by individuals who practiced ballet, those who practiced dance over a longer duration, and dancers who began dancing prior to age 12. It is important to note that although not significant, patterns of increased injury rate with younger onset of activity were examined in individuals who specialized in dance which was not apparent in those practicing other athletic activities.

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ACKNOWLEDGEMENTS

None.

FUNDING

The authors received no financial support for the research, authorship, and/or publication of this article and report no conflicts of interest.

Submitted: September 25, 2024 CST. Accepted: February 04, 2025 CST. Published: March 01, 2025 CST.

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