Analysis of Postural Risk and Pain Assessment in Bharatanatyam Dancers

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Abstract

Background: Bharatanatyam dance form is an amalgamation of emotion, rhythm, expression, and sculpturesque poses that demand high levels of physical and psychological power during a performance. Objectives: To explore musculoskeletal pain and analyze risk factors in Bharatanatyam dancers. The level of injury risk for the “Natyarambham” posture adopted by dancers was also assessed. Materials and Methods: A cross-sectional study was conducted in forty female Bharatanatyam dancers who received a minimum of 5 consecutive years of formal dance training from a recognized dance institute. A self-designed questionnaire comprising of demographic profile, dancing characteristics, presence of musculoskeletal pain, and specific area of pain according to the body region was administered. The injury risk of the “Natyarambham” posture was evaluated using a rapid entire body assessment tool (REBA). Results: Among 40 female dancers, 75% dancers (n = 30/40, 75% [95% CI 0.61, 0.89]) reported pain. The most common site of pain was the low back (n = 22/40, 55% [95% CI 0.39, 0.71]). Using Bonferroni correction for multiple independent comparisons, a significant difference was identified between dancers with and without pain for average performances per year (P = 0.028). As per REBA risk level scoring for Natyarambham posture, 62.5% (n = 25/40, 62.5% [95% CI 0.22, 0.53]) dancers were in the category of high-risk level. Conclusion: The findings of this study indicated that the point prevalence of pain in Bharatanatyam dancers is high. Natyarambham posture is considered high risk based on postural assessment.

Keywords: Bharatanatyam dancers, pain, posture, risk

Introduction

Dance, previously considered as a leisure pursuit, however, with the changing times it is now a well-renowned profession with proper training acquired by the dancers in a systematic curriculum. Dance, an independent industry, has an ever-increasing scope with many individuals choosing it as a career. It requires an individual to undergo a dedicated training at a younger age. Constant performances, long hours of rehearsals, skill-based movements, artistic poses, and maintenance of postures are frequent among dancers. They practice repetitive movements that require extreme flexibility, strength, and endurance which stress their bodies and make them prime candidates for overuse injuries which may have an impact on their future health. Bharatanatyam, an ancient Indian classical dance form, originated in Tamil Nadu, a region of southern India. This form is an amalgamation of music, rhythm, expression, and sculpturesque poses that demand high levels of physical and psychological power during a performance. The foundation of this dance form consists of basic steps along with rhythmic stamping of the feet and a multitude of crisp and meaningful hand gestures. Posture is one of the vital components of this dance form which comprises three basic positions namely—“Araimandi” (half-sitting position), “Muzhumandi” (full sitting position), and “standing”,[2,3] Natyarambham—a particular combination of arm positions with “Araimandi” posture is the main position maintained for the longest duration in the dance style. Gaining proficiency in this dance form requires rigorous training for prolonged periods of time while maintaining specific postures.[2,3]

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How to cite this article: Panhale VP, Walankar PP, Sridhar A. Analysis of postural risk and pain assessment in bharatanatyam dancers. Indian J Occup Environ Med 2020;24:66-71.
Dance injuries are common during the competitions or shows, especially when dancers are submitted to a heavy workload of rehearsals and classes.\[10,11\] Dancers are exposed to a greater risk of injury because of the duration and intensity of training.\[5-7\] Different dance styles have distinct characteristics, and there may be different types of injuries that are typical to each dance form.\[4\] Risk factors for dance-related injury are still not well understood.\[9\]

Although Bharatanatyam dance form is well renowned in the world, there is a dearth in literature with respect to the health issues of this population. Paul and Kapoor found that knee injuries were the most common type of injury among Indian classical dancers and revealed that 29% of the dancers were diagnosed with a torn meniscus due to their constant attempts to achieve the ideal form of araimandi.\[9\] Hence, the present study aimed to explore musculoskeletal pain and analyze risk factors in female Bharatanatyam dancers. Also, the secondary aim of this study was to assess the risk of the “Natyarambham,” a repetitive posture, commonly adapted by Bharatanatyam dancers.

**Subjects and Methods**

This is cross-sectional study design, utilizing exploratory analysis. It was conducted using a convenient sampling method after the approval of the institutional research review committee (MGM/COP/IRRC/117/2017). The target population was female Bharatanatyam dancers. A Bharatanatyam curriculum comprises an initial 5–7 years of training required to be qualified for graduation. The training provided is supervised by the dance teacher, qualified personnel. The inclusion criteria were female Bharatanatyam dancers in the age group 18–30 years with a minimum of 5 consecutive years of formal dance training from dance institutes and academies.

The majority of dancers belonged to three well-known dance institutes from Mumbai, Navi Mumbai, and Thane. The study was conducted for 3 months from August to December 2017. The sample size was forty Bharatanatyam dancers. The population size as per the inclusion criteria was 50 Bharatanatyam dancers. The sample size was estimated on the basis of population size as 50 dancers, anticipated percentage frequency as 50%, and absolute precision as 5% using Open Epi software version 3.01. Of the 40 dancers, 62.5% (n = 25) were students and 37.5% (n = 15) were professional Bharatanatyam dancers. All the dancers were explained about the purpose of the study and were assured of confidentiality and anonymity. Written informed consent was obtained from all participants in the study.

A 28-item structured questionnaire was developed based on a literature review on previous epidemiological studies in ballet and contemporary dancers and recommendations from key stakeholders including Bharatanatyam professional dancers and physiotherapists.\[10,11\] It is divided into three parts. The first part comprises demographic information—age in years, gender, and height in centimeter, weight in kilograms, and body mass index in kilogram/meter². The second part of the questionnaire consists of information about the dancing characteristics—minimum age when dance training began (years), duration of dance training including the formal training and rehearsal (years), dance exposure (hours of training per day), and an average number of performances in the last 1 year. It also assessed qualitative variables—performance of warm-up exercises before the training and cool-down exercises after the training. The third part of the questionnaire comprises the presence of musculoskeletal pain and specific area of pain according to the body region. The pain was defined as any self-reported pain present at the time of filling out the questionnaire. The body parts that are bilateral were counted as two-site (s) when both were in pain. The numerical pain rating scale was used to evaluate the intensity of pain. The assessor was present during the questionnaire filling to address any queries raised by the dancers. The face validity of the questionnaire was established with the aid of a panel of experts comprised senior physiotherapy faculty members and experienced dance instructors.

The injury risk of the “Natyarambham” posture of Bharatanatyam dancers was evaluated using a rapid entire body assessment tool (REBA). It segregates the body into sections to be coded independently according to the movement planes and presents a scoring system throughout the entire body.\[12\] Analysis of the “Natyarambham” posture was conducted in a reserved environment using a photogrammetric method. It was carried out by an experienced physiotherapist, qualified as a master of physiotherapy. The distance between the digital camera (13 megapixels OmniVision technologies by One Plus) and the subject was 2.4 m and the camera held 1.0 m above the ground. The room was well lit and privacy was maintained. Static photographs of the subjects in Natyarambham posture were taken in the frontal and sagittal plane. The REBA scores and the level of risk was determined. The REBA score grading system\[12\] is as follows [Table 1]:

**Statistical analysis**

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS version 16). Descriptive statistics were used to describe baseline characteristics of all participants using mean values and standard deviation (SD) for continuous variables or frequency and proportions with 95% confidence intervals for categorical variables. The differences among demographic and training characteristics between dancers with pain and dancers without pain were analyzed using independent t-tests in continuous variables. A P value of less than 0.05 was considered to be significant. As multiple independent t-tests were used, Bonferroni correction was applied to reduce the error.

**Results**

**Demographic characteristics**

Table 2 presents the demographic and dance training characteristics of the participants. Warm-up exercises were
performed by 45% dancers, whereas only 17.5% included stretching as a part of their cool-down routine. Also, 62.5% of dancers participated in other forms of exercise apart from dance, the most common being walking (56%).

### Pain profile
Among 40 female dancers, \( n = 30/40, 75\% \) (95% CI 0.61, 0.89). The most common site of pain was the low back \( (n = 22/40, 55\% \) [95% CI 0.39, 0.71]) followed by thigh \( (n = 19/40, 47.5\% \) [95% CI 0.31, 0.64]), knee \( (n = 19/40, 47.5\% \) [95% CI 0.31, 0.64]), calve \( (n = 15/40, 37.5\% \) [95% CI 0.22, 0.53]), and ankle \( (n = 14/40, 35\% \) [95% CI 0.20, 0.50]). The mean value of the intensity of pain noted was 6.82 ± 2.46 in the dancers with pain as per the numerical pain rating scale. Initially, a \( P \) value of less than 0.05 was statistically significant. However, multiple independent t-tests, total five, were applied, Bonferroni correction was used to minimize the error. Using Bonferroni correction, a \( P \) value less than 0.01 was considered statistically significant.

### Subgroup analysis between students and professionals in dancers with pain
Among 30 female dancers with pain, 56.67% \( (n = 17) \) were students and 43.34% \( (n = 13) \) were professional Bharatanatyam dancers. Initially, a \( P \) value of less than 0.05 was statistically significant. However, multiple independent t-tests, total six, were applied, Bonferroni correction was used to minimize the error. Using Bonferroni correction, a \( P \) value less than 0.01 was considered statistically significant. There was no significant difference between students and professionals in dancers with pain with respect to body mass index, dance exposure, average performances per year using independent t-test [Table 4].

**DISCUSSION**
This study explored musculoskeletal pain and analyzed risk factors in female Bharatanatyam dancers. Also, the risk of the “Natyarambham,” a repetitive posture, commonly adopted by Bharatanatyam dancers was assessed.

**Prevalence of musculoskeletal pain**
It was observed that 75% of Bharatanatyam dancers reported experiencing musculoskeletal pain indicating a high point prevalence of pain. This is consistent with a study performed in professional dancers in Australia which reported that 73% of dancers experienced a significant dance-related injury in the past 12 months.[13]
Low back, thigh, knee, calve, and ankle were the most common sites of pain reported by dancers. Dance combines artistic expression and athletic conditioning united in specific movements characterized by precise harmonious gestures. Such techniques require adopting postures that place stress on the musculoskeletal system.\cite{5} In Arai mandi position, the dancer must maintain an upright and erect trunk position with the abdomen held in and both knees and feet pointing in opposite directions. This position requires a combined motion of hip flexion, abduction, and external rotation, knee flexion, and ankle dorsiflexion in a closed kinetic chain position which compresses one’s height to at least 3/4 of their original height.\cite{14} In an attempt to increase “turnout” at the hip, there is a compensatory increase in lumbar lordosis which places the hip joint in a position where the capsular ligaments are loosened leading to anterior pelvic tilt. This increased lumbar lordosis elongates the abdominal muscles causing weakness, whereas the erector spinae and hip flexor muscles undergo shortening which further causes an imbalance in the lumbopelvic complex.\cite{14,15}

Thigh and knee were the second most prevalent sites of pain reported in Bharatanatyam dancers. Maintenance of Arai mandi posture and rhythmic stamping of the feet in this posture is most likely to strain the patellar tendon because of the transmission of force via the patella.\cite{10} Assumption of posture that involves forced turnout at the knee results in increased activity of the lateral knee stabilizers, leading to biomechanical imbalances at the patellofemoral joint.\cite{16}

**Risk factors**

It was observed that total training experience and performances per year were more in dancers with pain as compared to dancers without pain. There is greater exposure to training which increases the chances of a dancer suffering a musculoskeletal injury. It has been reported that classical ballet and contemporary dancers perform rehearsals for a prolonged duration, especially when upcoming performances are approaching.\cite{5} Thus, the greater exposure to training increases the chances of a dancer suffering a musculoskeletal injury. A study performed in 266 elite ballet dancers reported that with increasing training duration, there was also an increased risk of injury, particularly due to overuse.\cite{17} Further analysis done in dancers with pain revealed that there was a difference among students and professionals with respect to the duration of training. Professional dancers were exposed to increased and vigorous rehearsals with a focus on perfectionistic movements as compared to students which predisposed them to musculoskeletal pain.\cite{5,17}

Training in Bharatanatyam varies depending on the Guru (dance teacher) and the region in which the classes are conducted.\cite{2} In an attempt to achieve perfection in a dance posture or step, the compensatory strategy is adopted in such a way that the dancer may use either the correct muscles in a risky manner or simply recruit incorrect muscle patterns predisposing to pain.\cite{18} However, in this study, no dancer stopped dancing because of pain as according to them reporting about pain is considered a hindrance to their career. Most studies have reported that dancers were under pressure to return to dance before injuries healed because it is believed that as they have invested a great deal of time in dance they must perform through injury.\cite{19} Many dancers often stretch their physical capabilities and endurance and neglect their physical limitations. It is noted that very few dancers seek medical assistance in case of injury due to fear of cessation of dance training.\cite{20} Incomplete recovery, inadequate treatment, and early return to dance from initial injury are considered as a potential risk factor. Hence, incorporation of education and injury prevention strategies are essential in dancers at an early stage.\cite{5,21}

In our study, 45% of Bharatanatyam dancers performed warm-up exercises, whereas only 17.5% included stretching as

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**Table 4: Comparison of demographic and training characteristics between dancers with medium-risk and high-risk REBA level**

| Characteristics               | Medium risk (n=15) | High risk (n=25) | P  |
|-------------------------------|-------------------|-----------------|----|
| Age (years)                   | 20.3±2.32         | 22.04±3.39      | 0.94|
| Body mass index (kg/m²)       | 22.21±3.18        | 23.06±3.82      | 0.476 |
| Dance exposure (hours of training per day) | 1.96±0.95     | 2.02±1.43       | 0.899 |
| Minimum age when dance training began (years) | 6.9±2.83        | 6.32±2.01       | 0.454 |
| Duration of dance training (years) | 12.6±3.44       | 15.18±3.8       | 0.038 |
| Average performances per year | 6.87±4.13         | 8.65±5.47       | 0.287 |

*P value less than 0.01 is considered as statistically significant with an application of Bonferroni correction to multiple independent t-tests

**Table 5: Comparison of demographic, training characteristics, and REBA score between students and professionals in dancers with pain**

| Characteristics               | Dancers with pain Students (n=17) | Dancers with pain Professionals (n=13) | P   |
|-------------------------------|----------------------------------|--------------------------------------|-----|
| Body mass index (kg/m²)       | 22.37±3.4                       | 23.79±4.15                          | 0.31|
| Dance exposure (hours of training per day) | 1.71±0.85          | 2.73±1.6                            | 0.03|
| Minimum age when dance training began (years) | 7.21±2.72       | 5.23±0.93                           | 0.01*|
| Duration of dance training (years) | 12.61±2.99      | 17.77±2.92                          | 0.00*|
| Average performances per year | 7.56±3.94                      | 10.73±5.88                          | 0.09|
| REBA risk score               | 7.47±0.72                      | 7.85±0.8                             | 0.18|

*P value less than 0.01 is considered as statistically significant with an application of Bonferroni correction to multiple independent t-tests
a part of their cool-down routine. The performance of warm-up exercises increases core body temperature, which prepares the muscles and joints for the demands placed by the dance.[22] The cardiorespiratory, muscular, and nervous systems must be engaged before technical movements can be undertaken safely and effectively; by slowly and methodically allowing the mind and body to enter a state of enhanced preparation before the activity begins leading to enhanced focus on the technical and artistic demands of dancing. Dance requires high levels of concentration and mental readiness; this mental preparation can start with the warm-up which will potentially reduce the risk of injury.[22]

**Analysis of Natyarambham posture**

*Natyarambham*, the most commonly attained posture by the Bharatanatyam dancer, is the combination of the *araimandi* position along with arm movements and hand gestures. Dancers are instructed to maintain this position for a prolonged period of time in order to build the strength and stamina necessary to perform longer dances. Commitment to this level of training typically begins at a young age and occurs during the adolescent growth spurt involving repetitive movements. A wrong adaptation of this posture could impose excessive stress on the spine, especially the lumbar spine, and result in pain among the dancers. Therefore, the participants in this study who have had a significantly higher number of years of active dance experience demonstrated a higher risk of injury. As per REBA risk level scoring, the majority of dancers are in high (62.5%) and medium risk (37.5%) predisposing them to risk of injury. This study revealed that the higher the training duration, more will be the risk of injury.

**Strengths/Limitations/Future research**

The sample size in this study was small due to the limited number of a convenience sample of a highly specialized population, female Bharatanatyam dancers. Most likely, the pain results from a complex interaction of both environmental and personal factors. These environmental factors were not taken into account in this study. Documentation of dietary history may have added value to the study and provided an implementable recommendation to the dancer in pain which should be considered in future studies. Also, we did not carry out any basic physiological assessment of posture, flexibility, strength, muscle endurance, and cardiorespiratory capacity of the dancers which may have an impact on the health and injury risk of a dancer. This could be the scope of further studies on Bharatanatyam dancers.

**Conclusion**

The findings of this study indicated that the point prevalence of pain in female Bharatanatyam dancers is high. *Natyarambham* posture is considered high risk based on postural assessment. It is important that technique and training load are considered in future cohort studies examining injury prevalence in Indian classical dance. Dance as an individual profession should be analyzed further in details and preventive and rehabilitative strategies should be incorporated to prevent any injuries in the dancers.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

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