Survey of Musculoskeletal Disorders Among Indian Dancers in Mumbai and Mangalore

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Abstract

Classical Indian dance has earned recognition across the globe; however, the health of dancers who are carrying forth this heritage has not received due attention. Therefore, this study aimed to explore musculoskeletal pain and injury prevailing among Indian dancers in Mumbai and Mangalore. A secondary aim was to compare pain tolerance levels between dancers and non-dancers. Fifty-one dancers trained in different traditional Indian and Western dance forms and 164 recreational dancers were recruited as participants. An indigenous questionnaire was designed and validated by physical therapists across various levels of experience and dancers across various training levels. The questionnaire recorded dance, pain, and injury profiles. Additionally, pain tolerance was evaluated using the Pain Sensitivity Questionnaire among dancers and healthy age- and gender matched controls (N = 200). Descriptive statistical analysis was performed to present results of the site of current pain, site of past injury, perceived causes of injury, and exercise routine. The Student's t-test was used to compare Pain Sensitivity Questionnaire scores between dancers and non-dancers, and independent one-way ANOVA was used to compare scores among dancers practicing different dance forms. For both current pain and past injury, dancers reported the back (42.5%) followed by the knee (28.3%) and ankle (18.6%) as the most common sites. Stress was the most commonly perceived cause of injury (34.4%), followed by over work (24.7%), tiredness (17.2%), and falls (13.5%). Warm-up exercises were always performed by 43.30% of dancers, whereas only 20% performed stretching after dance. Almost 60% of dancers participated in forms of exercise other than dance, e.g., swimming, yoga, and aerobics. Pain sensitivity was not significantly different between dancers and non-dancers ($p = 0.159$). Level of training and gender did not influence pain.

Indian traditional dance encompasses various indigenous dance styles across India that originate from temple dancing. They are categorized into seven major kinds, namely Bharatnatyam, Kathak, Manipuri, Kathakali, Odissi, Kuchupudi, and Mohiniattam.[1] All Indian classical dances are rooted in Natyashastras (Indian treatise on performing arts) in varying proportions and, therefore, share common features such as mudras (gestures made with hands or fingers), body positions, and inclusion of dramatic or expressive acting, or abhinaya.[1]

Bharatanatyam is one of the most sublime and ancient of Indian classical dances; it originated in Tanjore, a town of Tamil Nadu in Southern India.[1] This dance form lays its foundation on the aesthetic beauty of angles and lines formed by various positions of different body parts.[2] Bharatanatyam is distinguished by its grace and style, it includes traditional poses, rhythmic foot stamping, jumps, pirouettes, and positions where the knees are in contact with the floor. Another dance form, Kathak, is a partially narrative form characterized by fast foot work (tatkar), spins (chakkar), and innovative use of bhav (expression) in abhinaya.[1,3] Odissi, a temple dance tradition from the Orissa state of India, is characterized by movement of the hips. This dance form includes variations of sitting, walking, leaping, and elevations that reinforce some of the basic therapeutic movements of the dance.[1] Kuchipudi embraces quick movements with rapid footwork and sharp turns requiring good balance. The therapeutic effect of this dance form is embedded in its grace and fluid movements.[1]

Indian classical dance is considered a high form of art and was practiced in courts, temples, and on special occasions, while folk dance forms are practiced in groups in rural areas as an expression of their daily work and rituals. Many folk dances are

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Figure 1 Common dance postures in Indian classical dance. **A**, Kurma (turtle) pose: excessive lordosis of lumbar and cervical spine with bilateral hip knee flexion and external rotation. **B**, Bhramari (jump) involves high impact jumping activities wherein dancers land directly on their toes. It also involves lateral flexion and rotation of the trunk along with flexion of both knees while taking off. **C**, Arimandi (plie): bilateral hip-knee flexion in full squat position with hip external rotation and ankle dorsiflexion. The trunk is erect. **D**, Tandav (dance) pose involves unilateral weightbearing on right leg along with left hip hyperxtension and passive knee flexion and ankle plantar flexion. The trunk is required to be maintained in extension and lateral rotation. **E**, Nritta (dance) pose: the right knee bears the entire weight in flexed position with right hip in flexion and external rotation. **F**, Matsya (fish) pose: the right knee is in slight flexion and bears the entire weight. The trunk is bent forward and maintained in horizontal position in line with left lower limb. This requires good balance and control.

performed by ordinary people, rather than professional dancers, during harvesting, planting, marriages, and religious holidays.[1] Some of the popular folk dances that are performed across villages and cities are Bhangra, Garba, Lavani, and Bihu. Irrespective of type of dance form, an exercise like dance requires much confidence, body control, and regular practice.[1]

Despite wide practice of several traditional Indian dance forms, extensive length of training, and performance life, Indian classical dancers' health problems are rarely explored. An analysis of musculoskeletal problems in female Bharatnatyam dancers reported knee (48.8%), low back (24%), ankle (12.4%), and the shoulder-neck complex (7.5%) as the most common sites of musculoskeletal pain.[4] Another study on Bharatnatyam dancers from two different dance schools also reported the knee to be the body part most prone to injury, followed by the foot, ankle, hip, and shoulder.[2]

In addition to classical Indian

dance, many Indians are now exposed to a variety of Western dance forms. The most common dance forms practiced in Western countries include: ballet, modern, tap, theatrical, folk, flamenco, break-dancing, ballroom dancing, and ice dancing.[5-11] In the United States, many surveys of the incidence and nature of injuries sustained by ballet dancers have reported pain in the lower extremity as the most common problem, followed by injuries associated with the knee, ankle, foot, and lower spine.[5-7] A 5-year analysis at the Alvin Ailey American Dance Center identified 58% of all dancers' injuries as occurring in the lower extremity, with 34% at the foot and ankle and 17% in the low back and pelvis.[8] Consistent with research findings in the United States, the back and lower limb were shown to be particularly vulnerable to injury in 141 dancers from seven professional ballet and modern dance companies in the United Kingdom.[9]

Western Dancers reportedly have a 90% lifetime injury incidence rate,[11] with approximately 70% of all dance-related injuries involving the lower extremity.[12] The best available evidence suggests that musculoskeletal injury is an important health issue in dancers at all skill levels.[13,14] A high prevalence and incidence of lower extremity and back injuries, with soft tissue and overuse injuries predominating, have been commonly reported in dancers.[5-14] However, it is not known whether similar pain and injury characteristics occur in Indian dancers, irrespective of practicing traditional or Western dance styles.

Health problems of dancers are worthy of attention for several reasons. First, as most professional dancers begin dancing at the age of 5 or 6,[15] repetitive practice of movements that require extreme flexibility, strength, and endurance makes dancers prime candidates for overuse injuries, creating the potential for a greater impact on their future health.[16,17] For many people, dance may not spring to mind when thinking about sports, but the physical demands placed on dancers' bodies[18] make them just as susceptible as sport athletes to injury.[2] Therefore, the present study aimed to explore musculoskeletal disorders (pain and injury) in Indian dancers, dancers' perception of the causes of injury, and their exercise routine. Lack of research, particularly in Indian classical dancers' health, acts as a barrier to providing scientific recommendations to prevent injuries and offer appropriate treatment. A secondary aim of this study was to compare pain tolerance levels between dancers and non-dancers.

Methods

After the study had received Institutional ethical clearance, 215 dancers across different age groups, dance forms, and training levels from dance institutes and academies were recruited. Informed written consent was obtained from all participants. The majority of dancers belonged to four well known dance institutes from Mumbai and Mangalore (southern part of India). Almost one-third of the dancers were university undergraduate physical therapy students who were trained in dance or who performed dance as a recreational activity. A small number were recruited through passive snowballing from participating dancers. Inclusion criteria were a minimum 1 year of formal dance training and the ability to comprehend questions in English. There was no age restriction. Participants were divided into Trained and Recreational groups based on their training duration. The Trained group was composed of dancers who had a minimum of 5 to 7 years of formal training along with a formal degree or qualification in dance; those in the Recreational group did not fulfill these criteria.

Dancers were also sub-divided into four groups based on their training in different dance forms: Bharatnatyam, Traditional, Western, and Mixed groups. The Bharatnatyam group included dancers who were exclusively trained and performed Bharatnatyam. The Traditional group included dancers engaged in one or more of the other Indian classical dance forms or any folk dance. The Western group exclusively trained in international dance forms like hip hop, contemporary, salsa, free style, jazz, ballet, and so forth. The Mixed group practiced or performed both Indian classical and Western dance forms.

A questionnaire was designed to explore dance type, pain, and injury profiles, along with demographic data to provide a brief overview of a dancer's career. The questionnaire included: medical history, dance form or style, length of dance career, duration of dance training, presence of supervised training, inclusion of warm-up and cool-down exercises as a part of routine training, site of present pain, past history of injury, and perceived causes of injuries. Pain was defined as any pain present at the time of filling out the questionnaire. Injury was defined as any past injury that caused dancers to miss a dance class, rehearsal, or performance. Content validity of the questionnaire was established with the assistance of a panel of experts comprised of senior physical therapy faculty members and experienced dance instructors. All participants completed the questionnaire independently.

Additional information on pain tolerance levels in dancers was sought using the Pain Sensitivity Questionnaire (PSQ), which is a valid self-rating measure of pain perception.[19] Higher pain sensitivity scores indicated lower levels of pain tolerance. Healthy age- and gender-matched individuals without any dance training and who did not perform dance even for recreational purposes formed the control group for PSQ score comparison. Control group participants were recruited from the Physiotherapy Institute.

Data Analysis

Data were analyzed using IBM SPSS Statistics software version 16 (IBM, Armonk, New York). Descriptive statistical analysis was performed for variables such as site, type and perceived cause of pain, exercise routine, and training level. The PSQ score followed a normal distribution in both

groups. Therefore, the Student's t-test was used to compare pain sensitivity scores between dancers and non-dancers, and an independent one-way ANOVA was used to compare scores between different dance forms.

Results

Table 1 presents demographic and dance characteristics of the participants. Of 215 dancers, 69 (32%) were males and 146 (68%) were females. Average training duration in dance was 7.70 ± 3.67 years. Among males, 3 (4.3%) were trained, whereas among females 48 (32.87%) were trained. Descriptive analysis of dance forms revealed that 16% were purely Bharatnatyam dancers, 15% exclusively practiced traditional dance forms, 45.5% were engaged in Western dance forms, and 24% practiced mixed dance forms. A large number of senior dancers refused to participate because they did not wish to answer questions pertaining to pain.

Pain Profile

Among combined trained and recreational groups of female dancers, 81% reported pain. Among male dancers, all trained dancers (N = 3) and approximately 61% of recreational dancers reported pain. The most common site of pain in both genders across different dance forms and levels of training was the back (42.5%), followed by the knee (28.3%) and ankle (18.63%; Tables 2 and 3). The prevalence of pain was similar among trained and recreational groups of female dancers, indicating that the level of training did not influence the occurrence of pain.

The mean PSQ score was higher in dancers compared to non-dancers, but the difference was not significant ($p = 0.159$). Among the dance groups, Bharatnatyam dancers reported a lower mean PSQ score compared to traditional and Western dancers, but again the difference was not significant ($p = 0.34$; Table 4).

Injury Profile

The back (42.5%) followed by the knee (28.3%) and ankle (18.63%) were the most frequently reported sites of past injury suffered by the dancers. The prevalence was exactly the same for the pain question and the injury question (Table 2). Dancers reported that stress (34.4%) was the major reason for sustaining these dance-related musculoskeletal injuries, followed by overwork (24.7%), tiredness (17.2%), and falls (13.5%). Suggestions reported by dancers to help them prevent injury included warm-up exercises (43.7%), followed by rest (31.6%), fitness programs (30%), strengthening exercises (26%), and the presence of an on-site physical therapist (23.7%).

Exercise Routine

The majority of dancers (43.30%) always performed warm-up exercises, whereas only 20% included stretching as a part of their cool-down routine.

Table 1 Demographic Characteristics—Age and Dancing Duration Across Gender and Training Levels (Mean and Standard Deviation)

	Males (N = 69)		Females (N = 146)	
	Trained Group (N = 3)	Recreational Group (N = 66)	Trained Group (N = 48)	Recreational Group (N = 98)
Percentage	1.39%	30.69%	22.32%	45.58%
Age (years)	22.66 ± 2.51	19.70 ± 7.72	23.06 ± 7.36	19.32 ± 4.97
Dancing Duration (years)	6	5.88 ± 3.06	13.32 ± 7.60	5.90 ± 4.48

Table 2 Distribution of Pain Among Dancers Based on Level of Training (N = 215)

	Males (N = 69)		Females (N = 146)	
Site of Pain	Trained Group (N = 3)	Recreational Group (N = 66)	Trained Group (N = 48)	Recreational Group (N = 98)
Back	100%	35.93%	43.75%	48%
Knee	NP	25.56%	33.33%	26%
Ankle	33.33%	14.06%	22.91%	19%
Shoulder	66.66%	9.37%	14.58%	16%
Neck	33.33%	14.06%	20.83%	16%
Hip	NP	NP	4.16%	7%
Thigh	NP	NP	10.41%	2%
Hand	NP	NP	NP	2%
Wrist	NP	NP	NP	1%
Presence of Pain	100%	61%	81%	81%

NP indicates "No Pain."

Table 3 Distribution of Pain Among Dancers Practicing Different Dance Forms (N = 215)

Site of Pain	Bharatnatyam (N = 34)	Traditional (N = 32)	Western (N = 98)	Mixed (N = 51)
Back	38.2%	25.0%	48.5%	47.1%
Knee	20.6%	21.9%	24.7%	31.4%
Ankle	26.5%	15.6%	16.5%	21.6%
Shoulder	5.9%	6.2%	12.4%	29.4%
Neck	17.6%	NP	16.5%	21.6%
Hip	NP	NP	6.2%	5.9%
Thigh	NP	NP	NP	9.8%
Hand	NP	NP	NP	NP
Wrist	NP	NP	NP	NP

NP indicates "No Pain."

Table 4 Pain Sensitivity Questionnaire Scores Between Dancers and Non-Dancers Across Different Dance Forms (Mean and Standard Deviation)

Group	PSQ	P-value
Dancers (N = 215)	70.90 ± 27.56	0.159
Non-Dancers (N = 200)	67.55 ± 19.56	
Dance Forms		
Bharatnatyam (N = 34)	63.68 ± 22.94	0.344
Traditional (N = 32)	70.08 ± 24.56	
Western (N = 98)	74.05 ± 29.34	
Mixed (N = 51)	70.70 ± 27.84	

Almost 60% of dancers participated in other forms of exercise apart from dance, the most common being swimming, yoga, and aerobics.

Discussion

The present study revealed that 73.5% of Indian dancers reported experiencing musculoskeletal pain in their dancing careers. Irrespective of dance form, back pain was the most prevalent followed by knee and ankle pain. The level of training and gender did not influence the prevalence of pain. Surprisingly, there was no difference in pain tolerance between dancers and non-dancers. Back, knee, and ankle were also the most common sites of past injury reported by dancers. They attributed their injuries to varied factors, such as stress, overwork, tiredness, falls, inadequate exercises, hard flooring, and inadequate diet. Most dancers routinely participated in other forms of exercise, namely swimming, yoga, and aerobics, apart from dance. Dancers were better aware of the benefits of warm-up exercises compared to cool-down exercises.

It was observed that sites of present pain and those of past injuries were similar. Possibly these dancers considered them to be the same construct. It is also likely that they did not seek any intervention for past injuries and continued to train with them, resulting in aggravation of symptoms that ultimately presented as recurrence of pain. For the purposes of this discussion pain and injury will be considered simultaneously.

As previously noted, back pain was reported as the most prevalent site of pain in both genders irrespective of dance form or level of training. Other studies have reported similar findings in professional dancers,[10,13,20,21] but not among amateur dancers.[22] It is likely that commonly reported causes of back pain, such as poor core muscle strength, excessive anterior pelvic tilt, tightness of back extensor musculature, and weak and long hamstring muscles[23-26] were responsible for back pain in Indian dancers.

In the typical postures of most dance forms, the low back can be hyperlordotic (see Fig. 1). Hyperlordosis often results from an attempt to increase turnout at the hip by putting the hip joint in a position where the capsular ligaments are loosened (hip flexion, or anterior pelvic tilt), which allows the femur to rotate more in the hip socket. The resulting hyperlordosis elongates the abdominal muscles, making them prone to weakness, whereas the erector spinae and hip flexor muscles remain shortened.[27] Such an imbalance in the lumbopelvic segment caused by forced turnout at the hip is likely to reinforce an exaggerated lumbar lordosis during relaxed standing.[27] Additionally, lordotic posture places more weight on the facets, which are not predominantly weightbearing joints but are sites of nociceptive tissue. Excessive narrowing of the intervertebral foramen caused by approximation of the pedicles as a result of hyperlordosis compresses nerve roots and their dural sheaths, contributing to back pain.[28]

It is known that in young dancers mechanical low back pain could represent a transient "overgrowth" syndrome wherein the growth of bony elements outstrips ligaments and tendons during the adolescent growth spurt[29-31] resulting in a combination of tight lumbodorsal fascia and hamstrings posteriorly and weak abdominal muscles anteriorly.[23,32] Repeated stress on a dancer attempting to use his or her body the way it was prior to the growth spurt could lead to stress fractures.[33] Considering that half the dancers in the present study were teenagers, poor pelvic strength and control could explain the common complaint of low back pain.

Some of the common postures in Bharatnatyam and other classical dance forms are highly demanding in terms of muscle control and balance,

challenging the stability requirements of the dancers and making them more vulnerable to back pain. Matsya (fish), Nritta (dance), Kurma (turtle), and tandava (see Fig. 1) are common poses that are likely to result in an increased risk of back pain due to the high velocity twisting and bending required.[33]

Knee pain was the second most prevalent site of pain reported in dancers across all dance forms. Several factors could explain knee pain among dancers. One would be the aramandi position in Bharatnatyam (see Fig. 1), which is similar to a demi-plié in ballet.[2] A high incidence of chondromalacia patellae among ballet dancers is substantiated and known to be related to the use of plié.[34] Aramandi posture has a closed chain knee flexion with hip abduction and external rotation (see Fig. 1). Rhythmic stamping of the feet along with high impact jumping (Bhramari, Fig. 1) in this posture is likely to strain the patellar tendon because notable force is transmitted via the patella while taking off or landing from a jump.[35,36]

Secondly, classical dancers (both Indian and Western) commonly assume postures that involve forced turnout at the knee resulting in overstretching of medial contractile and non-contractile structures. This causes weakening of the medial structures and subsequent increased activity of the lateral knee stabilizers, leading to biomechanical imbalances of the patellofemoral joint. This could be the reason for patellofemoral joint syndrome as has been commonly reported among Bharatnatyam dancers.[32]

Thirdly, short hamstring muscles may predispose the knee to pain. Decreased hamstring flexibility is known to be a risk factor for the development of patellar tendinopathy and patellofemoral pain.[37,38] Lack of flexibility may cause early muscle fatigue and alter normal mechanics of movement, thus predisposing the dancer to pain. Additionally, muscle tightness may lead to overuse injury or even produce early wear and tear changes in weightbearing joints. Only 20% of dancers in the present study practiced common stretching exercises as a part of their routine dance practice. Therefore, it is possible that dancers experience tightness in biarticular muscles like hamstrings and **gastro-soleus**, resulting in knee pain.[4]

Exploration of the dancers' perception of common factors causing dance-related musculoskeletal injuries revealed stress, overwork, tiredness, falls, inadequate physical exercise, hard flooring, improper diet, unsuitable stages, and cold environment as commonly suggested causative factors, similar to those reported previously.[39] Most studies that report dancers' survey responses have emphasized that dancers felt pressured to return to dance before injuries healed because of the belief that since they have invested a great deal of time in dance, they must perform through injury.[40] Dancing with biomechanical dysfunction or muscle imbalance can develop into serious problems that require discontinuance of dance activities, thereby adding to their stress levels.[41] Associated factors could be competition among peers,[5] faulty food habits, irregular sleep patterns,[42-44] frequent travel, and inadequate rest,[45] making dancers more prone to musculoskeletal disorders.[46]

Although the importance of warm-up and cool-down in general exercise and sports is widely acknowledged, awareness of its importance among Indian dancers is poor. Less than half of dancers in the present study (43%) performed warm-up exercises, and only 20% practiced cool-down in the form of stretching. Despite the near majority of dancers regularly performing warm-up exercise, musculoskeletal pain was widely reported. This could imply that it is not lack of elasticity that leads to musculotendinous injury, but rather injury occurs when the tension demands of the muscle exceed the tension generating capability of the muscle.[47] Almost 60% of our dancers participated in other forms of exercise apart from dance, most commonly swimming, yoga, and aerobics. This may have had an indeterminate effect on their muscle tension-strength balance.

One factor that may influence the development of overuse injury is the hypothesis that dancers have an increased pain tolerance[48] that allows them to keep dancing despite pain.[40] Our hypothesis was that dancers would report a high pain tolerance because dancing through pain and injury is a traditional practice ingrained in a dancer's mindset. Contrary to what was expected, dancers had no difference in pain tolerance compared to non-dancers. Possibly the young age of the dancers along with a low average training duration would not yet have allowed for maturation of the attitude required for tolerating pain.

Another reason for the lack of difference may be that senior dancers refused to share information regarding dance-related pain, thus removing possible pain-tolerant individuals. The refusal to impart pain information reflects the acculturated perceptions[31,49] that run deep and are likely present in most dance environments. Future research should determine if sociocultural perceptions could be influenced in such a way as to improve participation in rehabilitation. Ultimately, changes in prevailing dance attitudes could result in long-term benefits to prevent chronic injury.

There were a number of limitations to the study. Only dancers able to comprehend English were included. Although this may be perceived as a bias, in reality a large percentage of Indian dancers in major cities are educated in English. Secondly, the relatively short average training duration of 7 years meant it was not possible to explore injuries in dancers with longer training duration, possibly resulting in under reporting of pain and injury. As mentioned previously, older dancers with intense grooming in the culture of a dance form refused to participate in the survey; thus, the influence of the "no pain, no gain" concept could not be explored in depth. Thirdly, dancers were trained in multiple dance forms; hence the pain and injury profile exclusive to a single dance form (apart from Bharatnatyam) could not be explored. Fourthly, the miniscule sampling of trained male dancers (N =

Author: Column 2, line 6, see bold "gastro-soleus" – should this be "gastrocnemius and soleus"?

3) obviously precludes any generalization regarding that population.

The study reports findings based on a convenience sample recruited from academies and institutes located in Mumbai and Mangalore, which limits generalization to the larger dancer population across various zones in India. It may be argued that such a convenience sample is likely to be biased due to over or under representation of participants from a particular state in India. However, it needs to be emphasized that the sample was cosmopolitan in nature because students come from various states of India to study in these dance academies. Also, due to the use of passive snowballing, the overall response rate could not be determined.

Conclusion

Despite differences in dance styles, a similar pattern of musculoskeletal pain and injury was demonstrated between young traditional and Western dancers in India. It would be interesting to investigate whether biomechanical and energy cost demands are also similar between these two cohorts. Participation of more experienced dancers could have added rich data to the understanding of musculoskeletal pain tolerance as well as lifetime injury prevalence rates. Further research should focus on older dancers to explore whether they demonstrate different patterns of pain and injury.

Overall, the similarities indicate that the multi-disciplinary approach to maintaining dancer health established elsewhere in the world could be effective in India across dance forms. The positive attitude of the dancers in this study toward an onsite physical therapist to provide them with health care indicates that, at least in younger dancers, supportive health services would be accepted.

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