

Soulful rhythm, dancing bodies – A review on spirituality, pain tolerance, and the risk of lower extremity musculoskeletal and back injuries among classical Kathak dancers of India

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There are no conflicts of interest.

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Abstract

Background Dance and dancers reflect happiness, sadness, passion, anger, and all other emotions as every single dancing movement carries a significant signal that goes beyond words. Kathak, an Indian classical dance form, requires a divine balance between the soul and the physical body. This balance allows for a high pain tolerance of the dancers, but the spiritual nature of this dance form also generates ignorance and disinterest in their health seeking behavior towards injuries.

Objectives This comprehensive narrative review is aimed at exploring and examining the prevalence of lower extremity and back musculoskeletal injuries among Kathak dancers and proposes management strategies for their prevention and treatment.

Methods This review is based on a search of relevant articles, research papers, books and book chapters conducted across a wide array of online sources, utilizing the search engines like PubMed, Medline, CrossRef, etc. Considering the inclusion criterion, the review process included three stages: initial assessment of papers through title and abstract review, a detailed examination of relevant items, and systematic compilation of pertinent information into a categorized table under topical headings.

Results 42 out of 360 studies were identified. In the foot and ankle region of dancers were observed 34% of injuries; 28.3% were knee injuries, 17% in low back and pelvis region, 5–16% were thigh injuries.

Discussion/Conclusion Kathak dancers should be aware of the fact that despite high pain tolerance, ignoring the pain or injuries might affect them in the future. There is a need to develop supplementary exercise training programs and also spread awareness among dancers regarding their physical health and seeking medical care in time to delay/prevent lower extremity injuries.

Take-home message for students Dance serves as an excellent holistic exercise for achieving mental and physical fitness. However, dancers, specializing in various forms, are prone to injuries unique to their disciplines. Therefore, it is advisable to incorporate supplementary exercise training specifically tailored to individual dance forms to prevent injuries and enhance overall performance.

Introduction

”Dance is nature. Listen to your heart. It dances with its own rhythm. The biggest thing that classical dance and music do to you is help attain balance between your mind and soul.” Pandit Birju Maharaj (Sarkar 18.05.2023).

Dance brings tranquility to its performer and inspiration to those experiencing that performance. Much of that performance depends on the artist’s health and state of mind. To give a mind-blowing performance, dancers must be in excellent emotional and physical health. Indian Classical Dance involves such coordinated elements which are a fusion of spiritual, emotional, mental and the physical attributes. This can be confirmed by referring to Bharat Muni’s – Natya Shastra – the guide to Indian classical dance which states in its first Shloka (Sanskrit for verse, stanza, or proverb): ”Where the hand gestures are, the eyes follow; Where the eyes go, the mind follows; Where the mind is, there the feeling evolves; Where the feeling evolves, the expression ultimately arise” (Khunteta 2020).

Kathak, having its prime origin in North India, is counted among the nine classical dances of India (Dance 2024; Morelli 2010). The essence of Kathak dance, a form of storytelling and composition, can be traced back to its Sanskrit origins, specifically the terms ”Kathaka” (Lalli 2004) and ”Katha” (Shah 2007). ”Kathaka” refers to a skilled narrator or reciter (Lalli 2004) while ”Katha” signifies a story (Shah 2007). Over the past few years, Kathak has undergone changes, leading to a shift in the way it is practiced and perceived (Shah 2007). Kathakars (the Kathak narrators or performers) conveyed tales from grand epics and ancient mythology through the mediums of dance, melodies, and musical expressions (Massey 1999). The grand

epics and ancient mythology also include the world’s longest poem – Mahabharata – which is the basis of several Kathak performances. The performing art of Kathak has flourished as an oral tradition, passed down through generations via verbal guidance and practical training, continually evolving and benefiting from the valuable contributions of each subsequent generation (Shah 2007). Kathak follows an aesthetic tradition of guru-shishya parampara (Morelli 2010) which literally means an act of passing down whatever has been learnt and followed in tradition from the teacher to the disciples. This tradition nurtured close relationships with disciples engaging in long-term studies and periodically residing in the guru’s home (Morelli 2010).

It was noted that Indian classical dance forms have always been linked to therapeutic values (Chatterjee, Sudhakar, Singh, Raghupathy n.d., Kashyap) as cited in (Vishwakarma 2022). The practitioners of Kathak utilize the dance form to aid in the healing process and enhance overall well-being (Vishwakarma 2022). Spirituality has an intimate connection with Kathak dance and health-related behavior can moderate spirituality (Božek et al. 2020). The spiritual component of a classical dance style such as Kathak, influences the creation of many types of strategies, such as changing one’s perspective on pain to modify one’s behavior in response to it. The study and practice of Kathak dance serves as a catalyst towards high pain tolerance and often Kathakars consider pain as an opportunity to improve their skill (Harrison et.al, Pollard-Smirh & Thomson and Wainwright et.al) in (Soundy and Lim 2023; Tarr and Thomas 2011).

Characteristics of Kathak Dancers

“Nritta” and “Nritya” are two major aspects around which Kathak dancers revolve their performances. The former refers to the pure dancing, whereas the latter is the expression-based element (Koskoff 2008). The commencement of nritta based performance begins with a piece at a reduced speed focusing on the soft actions of wrist, eyebrows and neck that is referred to as Thath (Walker 2016; Netti et al. 1998). The Thath is based upon a set of mnemonic syllables called bols traditionally that help to identify the rhythm. Once the Thath is completed the pace of Kathak starts increasing with the dancer importing extra energy with grace (Netti et al. 1998). With the elevating tempo, the Kathak dancer starts performing intricate footwork along with sharp gestures. In the language of Kathak, we refer to such footwork-based sequences as Tatkars (Figure 1A) which are synced to the musical beats (tala) in a well-coordinated manner (Khokar 1984; Netti et al. 1998). The Nritya is the other aspect of a Kathak dance, which conveys a message or story to the audience through the inclusion of expressions, emotions and movements based upon the sequence of connection of words and beats (tala) (Descutner 2010).

When a performer starts with the intricate footwork or tatkars, the sound produced resembles a tight slapping effect due to the interaction of the foot and the floor or ground. This sound is perfect enough to echo in a hall. The grounding force generates energy in the body via vibrations, thus adding to the increased balancing. The energy flow occurs in a much-channelized format – from the feet into the body. What makes this piece amazing is that while tapping the feet on ground, the dancer is so well coordinated with her/his mind and

body that no focus goes on watching the legs, instead the feet guide the dancer as the muscle memory is well trained (Pendurkar 2022).

A Kathak dancer carries a rich knowledge of both asymmetry and symmetry from within as they acquire the ability to move various body parts in an independent manner. Dancing to a rhythm with fast movement yet smooth transitions amid the bols of the sequence, reflects the increased flexibility component of Kathak performers (Pendurkar 2022). Previous studies also reveal the great store of muscular strength and endurance among Kathak dancers. The abdominal strength and endurance of Kathak dancers are notably much higher than other dance forms, accompanied by an exceptional level of flexibility in the lower back. Dancers at all levels of physical and spiritual ability strive for further improvement by adapting their fitness goals and strategies (Kulshreshtha et al. 2022).

The weight of a dancer’s body while performing Kathak, if observed from both the horizontal and vertical axis, gets uniformly distributed. Neither the deviation in the lower body movements nor in the sharp bends in the upper body movements can be observed among Kathak dancers. The basic posture maintained is the standing one (Centre for Cultural Resources and Training 2020).

The Ghungroos, small bells that Kathak dancers wear on each ankle, may vary in quantity from just one to numerous and may reach a mass of about 2–2.5kg. These bells are fixed in place by a strong cotton string (Figure 1B). These bells add to the rhythm of the dance and add weight to the lower leg and ankle. The chakkars (pirouettes) (Figure 2A) are eye-catching movements that Kathak dancers perform which are knitted into various sequences that are a part of Kathak dance routines, such as Tukdas, which depend upon bal-

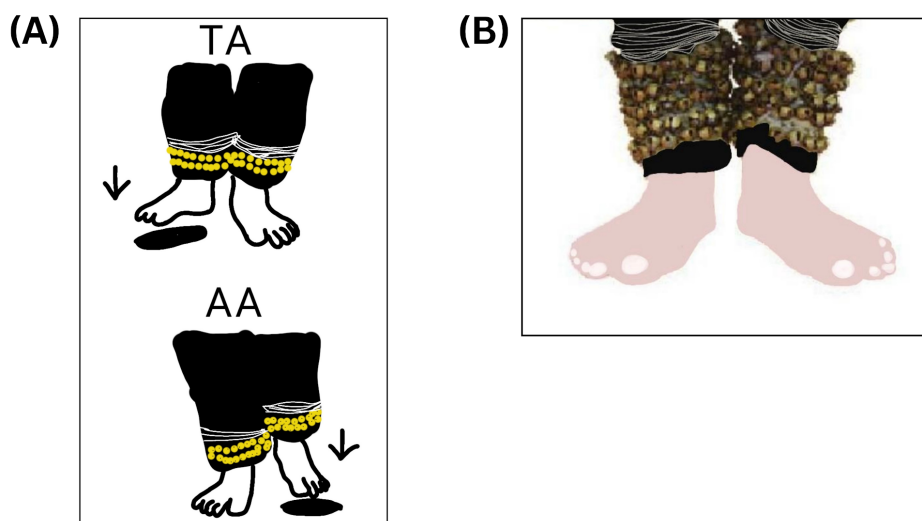


Figure 1 (A) In this visual tale is shown the *tatkar* i.e, the footwork sequences. The arrows signify the movement of the feet whereas the black big circle on the ground depicts the intensity with which the movement by a Kathak dancer is performed; this produces a slapping effect when feet are tapped on the ground. The words *TA* and *AA* are some of the *bols* (the rhythmic sequence with count) that are a part of oration, called *padhant*, at the time of practice.

(B) Figure showing the ankle bells or *ghungroos* tied on the legs of a Kathak dancer. These are small metallic bells generally made of brass tied on a thread to form a musical anklet that produces percussive sounds. Indian classical dancers have a tradition to worship *ghungroos* every time they start either practicing or performing. The *Guru*, teacher, touches the *ghungroos* of the student as a part of the blessing. (Original creation by co-author ASD).

ancing skills, tempo and toughness. Kathak dancers perform three types of chakkars – 1) right-to-left balance spin done with the help of taking five steps at a time (usually performed by a beginner level dancer), 2) a bi-step spin (Figure 2B) performed with a coordination of increased balancing and control in moderate speed, and 3) the fast paced spin performed on a heel (usually) with the utmost accurate rate and higher balancing skill (Pendurkar 2022).

When it comes to balancing, the reports have suggested that the balancing ability of the left leg is much greater among the dancers than the right one because in the Kathak dance the fast spinning and taking rounds follow the same direction, with the left leg balancing the body in the whole run. Therefore, dancers have also been termed as skilled athletes (Kulshreshtha et al. 2021; Wyon et al. 2007) and aesthetic sports participants (Arcelus et al. 2014;

Dosil and Díaz 2008) by some of the previous studies.

Types of injuries associated with Kathak dance

According to the World Health Organization (WHO), the identification of musculoskeletal injuries and conditions can be traced by the presence of persisting pain along with a hindrance in performing any movement with full completion. These injuries and conditions can range from short-term to long-term types or even life-long, from childhood till the older age (WHO 2022).

Due to the distinctive features of each dance style, it follows that there exist specific types of injuries that are particular to each modality (Bhutada and Pawar 2022).

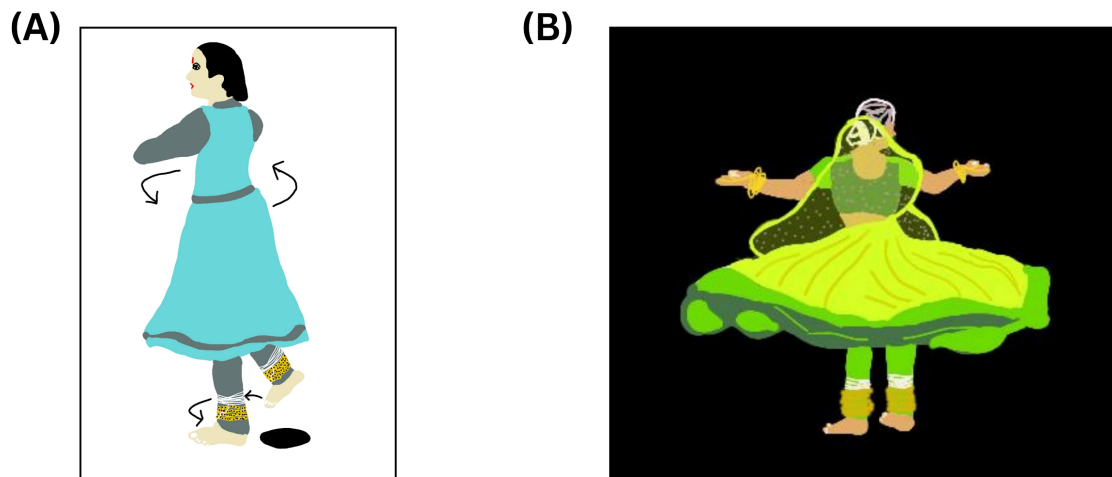


Figure 2 (A) Illustration capturing a turning posture during the chakkar or bhrumari (pirouette). This is a one-step chakkar that the male Kathak performer is taking; left leg is still in its place and helping to swirl or rotate the entire body in a circular manner. The arrows showcase the pattern of the movement. The attractive element of bhrumari is that the dancer doesn't look down to the feet while performing the move, rather in a very rapid manner the feet lead the entire body.

(B) In this illustration is shown the bhrumari or the chakkar performed by a Kathak dancer. This swirling movement is based on three steps. This generally is performed at a moderate tempo. The entire body is straight with the hands opening outwards. (Original creation by co-author ASD).

The existing literature notes that there is a limited amount of literature available on injuries related to Indian classical dance (Anbarasi et al. 2012; Prakash 2016). It was observed among all types of professional dancers that traumatic injuries were the most common type (Malkogeoros et al. 2011; Masal and Borkar 2021; Prakash 2016) (Smith et al. 2015). When it comes to the injuries among Kathak dancers, lower extremity and back musculoskeletal injuries are likely to be the most common. The following associated injuries might occur among Kathak dancers (Kadel 2006; Nair et al. 2018; Sabharwal and Singh 2017b; Bhutada and Pawar 2022; Prakash 2016):

- a. Back injuries
- b. Hip injuries
- c. Thigh injuries
- d. Knee injuries
- e. Foot and ankle injuries

Why study the back and lower extremity musculoskeletal injury among Kathak Dancers only?

Compared with the other Indian classical dance forms, Kathak is considered to involve more footwork, rapid movements, and complex weight shifts generating stress on specific muscles and joints. Hence, the probability of back and lower extremity-based injuries for Kathak dancers is increased. Kathak dancers also wear Ghungroos (ankle bells). The investigation of the movement patterns among Kathak dancers associated with the proper tightening of the Ghungroos is equally important as many dancers face the issue of either extreme tightening of the bells or loose tying of the ankle bells. This understanding can aid in designing injury prevention strategies. Certain muscle groups become either extremely active or under-active as Kathak involves the repetition of the movements which in body turns generate

a muscular imbalance. Such imbalance is a requirement of Kathak dance to keep the footwork both intricate and fast paced. A consequence is that Kathak dance technique may lead to changes in the skeletal-muscular structure associated with injury risk. These reasons make Kathak an apt choice for study of back and lower extremity musculoskeletal concerns.

Keeping the above backdrop in mind, this review is conducted to contribute to the existing literature by providing a comprehensive overview of the occurrence and treatment approaches for back and lower extremity musculoskeletal injuries in Kathak dancers. The following are the objectives of this study:

1. To understand the impact of the spiritual aspect of Kathak dance on performers leading to the attitude of high pain tolerance among them.
2. To study prevalence and the types of back and lower extremity musculoskeletal injuries and their presence impacting the performance of Kathak dancers.
3. To analyze the role of preventive measures (including proper warm-up, conditioning exercises, and footwear) in reducing the occurrence of musculoskeletal injuries in Kathak dancers.
4. To propose recommendations for injury prevention and treatment management strategies specific to Kathak dancers.

The organization of the review is driven by the following hypotheses:

1. The spiritual connection among Kathak dancers allows for high pain tolerance leading towards the ignorance of injuries ultimately affecting them in the longer term.
2. The occurrence of back and lower extremity musculoskeletal injuries is reduced when a Kathak dancer incorporates consistent warm-up and stretching during the practice session along with suitable training related to the strength-

ening and conditioning of the lower extremity.

Methods

Literature Search Strategies

This comprehensive narrative review is based on a search of relevant articles, research papers, books and book chapters conducted across a wide array of online sources, utilizing the following search engines:

1. Pubmed
2. Google Scholar
3. ResearchGate
4. Medline
5. CrossRef

The keywords used for the searches were: "Spiritualism", "Musculoskeletal Injuries", "Lower Extremity Injuries", "Kathak", "Classical Dance", "Stress" and "Ankle Pain". (Figure 3). The management and organization of the source materials identified during the search process were facilitated through the utilization of Google Docs and Google Sheets. The review process involved three distinct stages. In the first stage, a preliminary assessment of the papers was conducted based on the reading of their titles and abstracts. The second stage comprised a thorough and detailed examination of relevant items. Lastly, in the third stage, all relevant information from the sources was systematically compiled and organized in the form of a table, categorized under topical headings.

Inclusion Criteria

- a. Full text articles,
- b. Previously published relevant interviews,

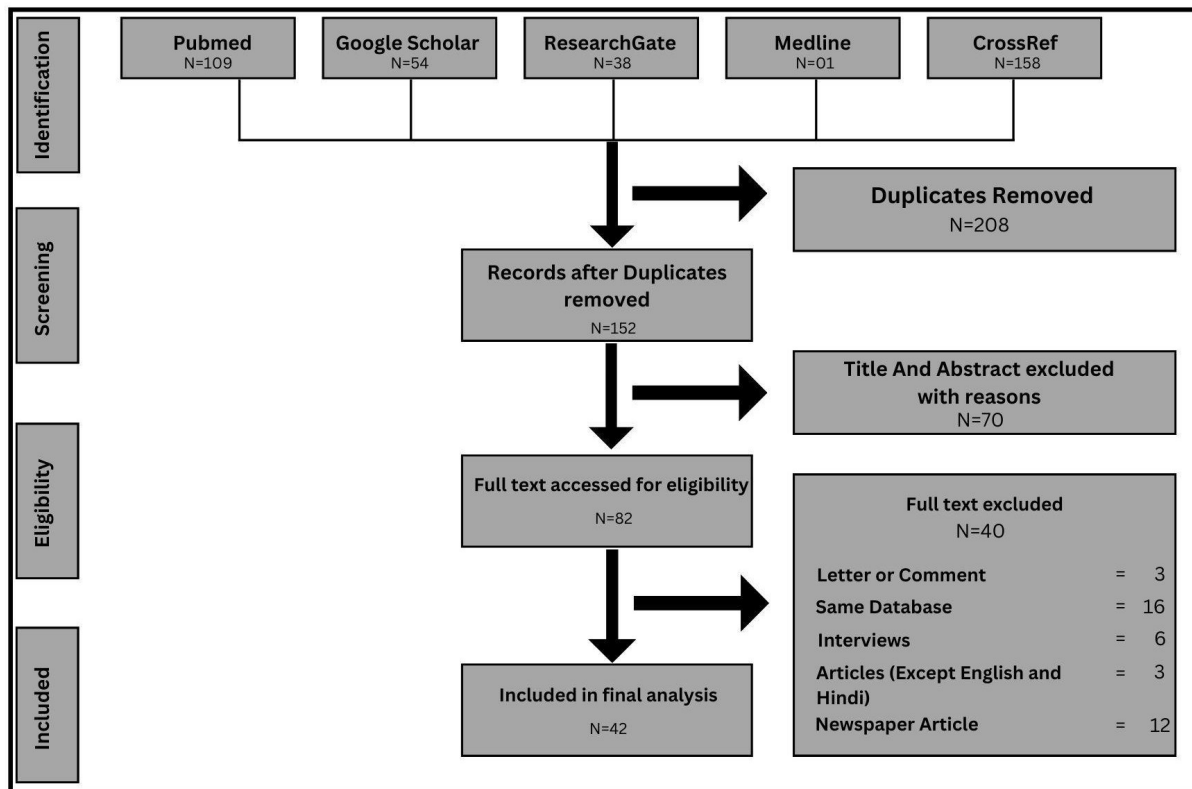


Figure 3 The flowchart representing the selection criterion used in the review.

- c. Cross sectional study and observational study,
- d. Systematic reviews,
- e. Newspaper articles,
- f. Website articles and Blogs,
- g. Indian classical dancers between the ages 10–45 years old,
- h. Indian classical dancers of all genders.

Exclusion Criteria

- a. Duplicate articles,
- b. Case reports,
- c. Articles with only abstract,
- d. Statistics which did not present specific percentage of injuries.

There are no new or prospective data in this review. No participants were involved, rather all information is from previously published sources.

Results

Causes of Musculoskeletal injuries among Kathak dancers

Participation in a variety of dancing movements is associated with an elevated risk of musculoskeletal injuries (Malkogeoros et al. 2011). In the case of Kathak artists, it is common to experience significant back problems as well as endure foot injuries such as painful heels and calf muscles (Basavarajaiah 2011). The practice of Kathak dance involves the execution of high-speed swirling movements across the dancer's entire body (Sivkishen 2015). During a performance, Kathakar's dynamic movements and precise footwork are perfectly timed to the tala (musical beats), showcasing footwork sequences called tatkar (Khokar 1984; Myers et al. 2003). Tatkar is a set of beautiful tapping work. Excessive and repetitive tapping can

contribute to the development of inflammatory conditions like dancer's tendinitis, as well as the flattening of the medial arch (Haas 2010).

“Today, Kathak is being highly appreciated and performed on a common platform with flamenco and tap dancing; it's a novelty in itself,” said Nandani Mehta, a Bangalore-based Kathak dancer (DHNS 11.08.2012). According to an article published in Hindustan Times, a Mumbai-based Kathak dancer pointed out the difference between the tap dancing and Kathak's footwork, “The difference is that while Kathak dancers perform barefoot, with ghungroos, tap dancers wear metal-soled shoes” (Kadokia 20.01.2017). The ghungroo (ankle bells) that can be found on each ankle emphasize and amplify the tapping and other work of the legs and feet. Less prevalence of injuries are reported among the tap dancers (Mayers et al. 2003) according to a previous study whereas one of the reports suggest the common issues, such as blisters, shin splints and ankle sprains, may persist among them (Mohanathasan 2021; Russell 17.01.2012). Among Kathak dancers, the foot experience an increased strain due to the additional weight and pressure exerted by the ghungroos (Sabharwal and Singh 2017a; Sivkishen 2015). Kathak dancers are highly prone to various foot problems and injuries due to the constant exposure of their feet to forces that can cause instability and postural deviations (Sabharwal and Singh 2017a). A dancer's lower limb strength plays a definite and important role in their overall fitness (Hamilton et al. 2008; Otari and Puntambekar 2021; Masal and Borkar 2021). An enhanced muscular strength is an indicator of excellent dance performance (Koutedakis et al. 2005). At the same time, experienced dancers are at an elevated risk of experiencing pain due to strain and have a strong ethic to continue

dance even when suffering from musculoskeletal injuries (Valenti et al. 2011).

One must give due consideration to the flexibility possessed by the dancers as only then may particular remarks be given regarding the occurrence of injuries (Prakash 2016). Dancers who have spent several years performing physically demanding positions are likely to experience the majority of dance-related injuries, primarily due to the consistent stress placed on weight-bearing joints (Anbarasi et al. 2012). The force generation can also be affected by body mass, and participant populations with diverse body mass index (BMI) may present different degrees of risks for dance-related injuries (Prakash 2016). Although learners may make a bit of modifications to their postures to adjust according to their body inclinations, the core and basic movements remain the same overall (Morelli 2010). Previous studies have shown that out of all the performing dancers, back pain is the most common of all the injuries suffered. Whether this is also true for Kathak dancers is not known.

Also, a study conducted by Chandan and colleagues suggests that changes in lower limb motion and muscle activity can be attributed to neurological and rheumatoid diseases (Chandan et al. 2018). Previous research indicated that the presence and prevalence of muscle tightness increases the chance of various injuries (Chandan et al. 2018). These findings for Kathak dancers are in keeping with data regarding classical ballet dancers which claims that 64–80% of their injuries constitute the lower extremities, with soft tissues and muscles being the most affected (Shan 2005).

Factors Affecting Injuries in Kathak Dancers:

One can hardly blame any single factor when it comes to the prediction of the

occurrence of the injuries, yet there can always be a probability for injury due to the amalgamation of extrinsic, intrinsic and condition-based elements which are more or less responsible for the injuries to occur (Arcelus et al. 2014; Dosil and Díaz 2008; Liederbach et al. 2008). These factors include muscle fatigue, imbalance, weakness, age related issues, and inadequate warm-up. If prior injuries have occurred to the same tissues this could be underlying causes of new injury (Askling et al. 2008; Croisier 2004; Cross et al. 2004; Garrett et al. 1984; Gupta et al. 2004; Ibrahim et al. 2007; Ojofeitimi and Bronner 2011; Petersen and Hölmich 2005; Renstrom 1992; Sherry and Best 2004; Tyler et al. 2002).

a. **Age:** Dancers in the adolescent age group often experience a sudden growth spurt, averaging six or more centimeters of total height increase in one year (Bogin 2021a). Rapid growth of the long bones can cause a tightness of soft tissue (tendons, ligaments) across the joint, ultimately reducing flexibility. Keeping this in mind, during the times of rapid bone growth, stretching exercises are mandatory to maintain harmony of function of the joints relating to the group of muscles, soft tissue, and bone. Indeed, stretching exercises are required by dancers during their entire professional life (Dalton 1992). The prevailing findings and discussion in the literature concludes that the lower extremity is the predominant region of occurrence of the musculoskeletal problems in the adolescent body (Deleget 2010). Hence, age is among the significant variables that play a role in the occurrence of injuries. During the adolescent age the dancers should be aware of many situations like “overgrowth” syndrome that occurs during the adolescent spurt when the growth

of bones outpaces the development of tendons and ligaments (Hasler 2013; Purcell 2009; Anbarasi et al. 2012).

Physical function usually reaches its peak between 20–30 years of age and then declines occur (Tanaka and Toussaint 2023). Older dancers may be more likely to sustain injuries as the skeleton, muscles and other support tissues age. Older dancers may compensate via enhanced spiritual, emotional, cognitive, and behavioral experience, strategies, and resilience. The interplay between biological, psychological, and religious factors means that there is no simple trajectory for “aging” and no simple prediction for injuries. An anecdote concerning age and Kathak dance was recently in the news regarding the “urination incident” during an Air India flight. The Hindustan Times headline read, “Air India urination case: Kathak dancers do not have bladder problems, say enraged artistes.” The article reported that classical dancers refuted as nothing but bizarre the statement claiming that 80% of Kathak dancers undergo bladder issues (Das 2023). Independent of dance, age plays a specific role as confirmed by the classical dancer Seth, “When a human gets older, the bladder gets weaker, so in such unfortunate circumstances, things like this may happen. But Kathak or dance has nothing to do with this” (Das 2023).

b. **Physiological:** Injuries can be influenced by various physiological factors. Body symmetry plays a vital role, for example, if there is an imbalance in leg strength, the performer may become more liable to injuries (Gupta et al. 2004). A study conducted by Banerjee and colleagues suggests that the performers practicing Indian classical dance like Kathak and Bharatanatyam have increased values of Vital Capacity

(VC) and Forced Expiratory Volume (FEV) that adds up a beneficial effect on the functioning of lungs (Banerjee et al. 2014). In the words of Ponce and colleagues FEV refers to the amount of air a person can exhale with force within a specific time frame (Ponce et al. 2023). Both the aerobic and lung capacity can be improved greatly with an elevated rate if creative dances like Kathak are a part of the daily schedule of physical activity (Quin et al. 2007). The previous studies also suggest that Indian classical dancers have lower resting heart rate which signifies an increased level of cardiovascular fitness. Individuals who are not practicing in any sort of physical activity, and are inclined towards the sedentary way of living, exhibit higher systolic blood pressure as compared to the dancers practicing regularly. In contrast, no distinction could be marked between groups for diastolic blood pressure. The pulse pressure among the dancers performing classical is also minimum (Banerjee et al. 2018). The studies claim that the pulse pressure is a standalone predictor for the conditions such as chronic kidney disease, heart failure, coronary artery disease and cerebrovascular disease (Franklin et al. 1999). Higher pulse pressure leads to greater risk for cardiovascular damage (Banerjee et al. 2018). Notably lower value of the Robinson index, a measure of how much oxygen your heart needs at rest, was found among the dance performers. This suggests a healthy status for dancers related to cardiovascular health (Pal et al. 2016).

c. **Genetic factors:** There are several skeletal problems with known genetic etiology. One is scoliosis and may be a factor that can affect dancers and contribute to injury (Virmani 2018). Scoliosis is a medical condition where

the spine of an individual develops a lateral curvature (NIAMS 2001). Joint hypermobility syndrome is another condition when the joints become extremely flexible resulting in pain (NHS 2023); this acts as a factor towards the increased probability of injuries. Another is pes planus, an angulation of femoral head and leg length discrepancy that may increase the likelihood of injury among these dancers (Virmani 2018).

d. **Psycho-social factors:** In addition to the physical requirements of Kathak, a survey of dancers reported that a leading cause of dance-related musculoskeletal injuries was social-emotional stress, accounting for 34.4% of cases (Masal and Borkar 2021). Factors such as peer competition, poor eating habits, irregular sleep, frequent travel, and lack of rest are sources of stress and contribute to dance-related musculoskeletal injuries (Kulshreshtha et al. 2021; Prakash 2016). Stress may also come from Social-Economic-Political-Emotional (SEPE) factors in the general society. Stress from SEPE factors can delay and otherwise impact the physical growth and development of children and adolescents, making them prone to injury and ill-health (Varela-Silva et al. 2016; Bogin 2021b). SEPE factor stress is present in all nations and all social groups, but is especially strong in nations such as India due to a history of colonialism and the social disruption. For Kathak dancers, the combination of physical and SEPE factor stress results in musculoskeletal injuries, which are most likely to occur on a Kathakar's lower extremities due to the greater pressure placed there (Masal and Borkar 2021). Motivation is another factor that may affect dancers. Several theories related to motivation propose that human

beings have an innate inclination towards achieving self-actualization and individual social-emotional growth. Self-actualization is often defined as the realization of an individual's potential by getting involved in life activities which are meaningful and aligned with the person's principles (Maslow 1954; Waterman 1993). A general finding of such research in physical performance is that positive mental skills and techniques are related to a higher level of performance and lower risk for injuries.

Moreover, for the development of talent attributes, such as psychological traits, social network support, cognitive abilities and career management skills play an essential role. Financial stability is also a factor, especially for the professional, independent dancers (Aujla and Farrer 2015). The moral support provided by the guru (mentor) and parents or guardians plays a crucial role as well.

- e. **Extrinsic factors:** Overworking is one extrinsic factor related to injury (Krasnow et al. 1999). In particular, time extension or excessive duration of the training (Virmani 2018). The training must not be stretched for a long period and there must be some gap or interval as a part of the rest session. Clothing is another extrinsic factor. Dance costumes must be flexible enough so that the dancers feel comfortable, and the risk of injury is minimized.
- f. **Environmental:** One environmental factor is appropriate flooring to maintain the health of dancers (Virmani 2018). Dynamic body movements are generally best supported by the sprung wood floors, whereas non-sprung wood floors generate a bad impact on joints of the dancers (Walden 2022). Dancing on hard surfaces and unsuitable stages are the causative

factors behind such injuries (Krasnow et al. 1999).

Important factors in a dancer's lifestyle are calorie intake and diet quality as these are not merely a part of performance but also essential for body metabolism. There should be a balanced diet that should be made part of the training routine; neither too much nor too little. If a dancer performs on a regular basis for more than 60 minutes then the need for water may increase above three liters. Fruits are also an important part of the dancer's diet schedule (Fine 2021).

- g. **Temperature:** Exposure to a cold environment is one cause of injury risk (Krasnow et al. 1999). A report suggests the temperature range of 68–70 degrees in Fahrenheit scale (20–21 Celsius) as the ideal one for both the practice and the performance (Walden 2022). Temperatures below this are not suitable. Additionally, the dancers should be precautious especially before and after the performance by avoiding getting too cold (Walden 2022) for example, drinking icy-chill water, cold drinks, etc.

Exploring the high pain tolerance amid the spiritual aspect of Kathak: Is the attitude really positive or does it lead to negative outcomes?

The well-known Kathak artist Pandit Chitresh Das once said, "As dancers, we don't go to the temple to worship the deity, we become the deity through dance, and by this, a profoundly devotional practice is established in which the dancer can often feel transformed to a higher level of connection to the essence of that particular god or goddess they are portraying" (Shaikh 2014). In the light of Kathak dance, the statement by Pandit Das captures the essence of

the spiritual and devotional aspect of this particular classical dance form. A Kathak dancer, when dedicating a piece to a specific god or goddess, connects to the deity and feels that spirituality around their soul by going beyond the physical movements and external expressions. Kathak is rooted in spirituality and devotion. In the process of accepting and internalizing the role, the dancers undergoes a transformative stage. This transformation leads to a greater sense of spiritual connection and feeling of unity with the divine.

Quoting another statement given by Akram Khan which signifies an aesthetic element of Kathak as a classical dance form, “It can erase walls and boundaries within us. This may be momentary, but serves as a reminder that the walls are man-made, mainly coming from a place of fear” (Howlett 2018). The statement explains the interconnectedness that Kathak as a dance form provides. Kathak has an additional beauty where the sharing happens as a harmonious interplay within the group since the dancer or group of dancers can be seen on stage but behind them is a team of musicians providing rhythm. The history of Kathak is one of great transformations among the people, their everyday society, and their religious culture because of the spiritual and divine connections. This is well explained by the words of Pandit Das, “From its early form as devotional expression dedicated to the Hindu gods, Kathak gradually moved out of the Hindu temples and was brought into the lavish darbars (courts) of the Mughal emperors as a form of entertainment taking on aspects of Persian music and poetry, along with movements and gestures that were uniquely indicative of Mughal culture. Kathak is said to be the only classical dance that is an outcome of Hindu and Muslim cultures. I repeat – cultures” (Shaikh 2014). His strong emphasis on the word “cultures” means it all. A great evolution was witnessed in

the history of Kathak, in large part due to its power to transcend geographic and cultural boundaries. The Kathak dancers plays a central role in these social and spiritual transformations. With this role come feelings of great responsibility for a high level of performance. Both opportunities for excellence and risks for failure and injury come with these feelings.

In one of his interviews, Guru Sri Mysore B. Nagaraj shared a beautiful instance when he was performing for the very first time abroad, “During my first performance there I noticed that I was not connecting to the audience through the stories from our epics and gestures that are easily recognizable in our culture like holding a flute to show Krishna. She (the organizer) told me the story of how all the residents of the island, except those who followed an old man to safety in the church, had died in a storm. For the next performance, I presented this story in my dance, and the audience connected immediately” (Nair 2022). The connectivity of oneself with divine power is of great importance to the dancers, but at the same time the professional dancers has to connect with the audience and for this crafting a performance that effectively communicates and engages is necessary. By this a bridge of understanding allows the audience to connect with their emotions and the greater spirituality.

“Dance is a form of worship and this body is an instrument of devotion. I strongly believe in this statement and try to pass it on to all my students as well. For me, dance is the means to attain what many would call spiritual bliss or a higher plane of consciousness, frankly a high on dance. This is what drives me. I believe the purpose of my art is to share this bliss with the audience through performance” (Nair 2022).

In many cultures, dance has been considered as a sacred form and Indian classical dance falls under this category. As a clas-

sical dancer, one views the dance as more than a mere performance. It is a pathway to spiritual bliss and a higher plane of consciousness. The purpose of an Indian classical dancers is not just entertainment but also to share this spiritual bliss that comes along with the movements and expressions during the portrayal of the character with the one who is watching it. In turn, this can be sensed among the audience in the form of energy they express.

In addition to spiritual/religious feelings, Kathak dancers face social issues related to gender identity. These issues may provoke feelings of stress that could affect the dance and the risk for physical injury. Gender has an intimate relationship with Kathak as a classical dance form. The character that is portrayed by the artist is completely gender neutral, meaning that the artist has to reflect whatever role is being depicted to the audience irrespective of the gender of the character being played or the gender of the artist. Kathak has always been an accepting form of dance, and this can be confirmed by the statement given during an interview by Devendra S. Manglamukhi, India's first transgender Kathak performer and teacher, "Life is not a bed of roses. Hence, I have chosen to be an artist and convey the meaning of life through art. I want to inspire the others in my community through Indian classical dance and do well in the stream of my classical dance. I want inclusion in society through Indian classical dance and music. I want equality, respect, acceptance, love and nothing more" (Jain 2020). Art has this unique way of touching people's hearts and thereby generating a positive impact among all. With the power to transcend language and gender-based barriers, the dance form strengthens the feeling of oneness. At the same time, the artist can strongly feel that the journey may come with challenges, just as life itself is not always so smooth. Guru Nagaraj also claims

that, "Male dancers are in demand everywhere" (Nair 2022).

"Yes, classical dance is one of the ways to connect with the divine. Hence it is called a sadhana (one of a number of spiritual practices or disciplines which lead to perfection). I tell my students to imagine that each time they strike a pose (sama), let their eyes look at God Krishna, that way there is an inherent bhakti (devotion) in the dance. The tatkar (footwork) practice should be like a japa (chant) where instead of 'hare ram hare krishna' we are saying 'na dhin dhin na' (The bols used during Tatkar and the sound made by the Tabla drums). When dance is done with that emotion, it connects us to the divine," said the late Kathak dance exponent Pandit Birju Maharaj (Art Of Living 2015). The way Pandit Maharaj explained the spiritual connection of Kathak dance is extremely valuable.

Shining the light on the firmness and stability that comes through Kathak, the name of Shruti Gupta who holds an international honor in Limca Book of Records for dancing barefooted at an altitude of 17,198 feet and performed at five Himalayan passes should come up. Quoting her, "I don't get a headache and altitude problem because, in my daily walk of life, I don't prefer a car. I get most of my work done by walking and in addition, I practice yoga and dance most of my time. That's why I don't get into problem dancing at such a high altitude" (Chorol 2016). This shows the divine connection and firmness within the Kathak dancers that make them tough enough to perform at very high altitudes and with pain and injury at any altitude.

Seema Mehta, the disciple of Pandit Das, spoke of the preservation and the connection of Indian classical dance art and spirituality. In her words, "If it had not been for the artists over the centuries, the oral tradition of religious storytelling would not have been preserved. It's such a shame

that society doesn't value this aspect of our culture nor see the connection between art and spiritualism" (Shaikh 2014). By celebrating and supporting artists, we can ensure the preservation of these aspects of the culture and spirituality so that it continues to enrich the future generations.

It is appropriate here to quote Khan regarding the comment he made on Indian classical dance and its spiritual connection, "Indian dancers place themselves in the shoes of Gods as well as mortals. And empathy is extraordinarily important—facial expressions and subtle body language communicate so much. I feel we're drifting away from empathy in today's world, and dance invites us to return to it" (Howlett 2018). In today's digital and fast-paced century, genuine human connections and ultimately empathy may be lacking, yet Indian classical dances like Kathak provide the social, emotional, and spiritual aspects that can lead to reconnection. Khan additionally added, "As a dancer, one must strive to elevate their mind and soul. Always remember Dance is a medium of worship and your body is an instrument of devotion" (Howlett 2018). Indian classical dance hence can be termed as a channel that expresses devotion towards the divine. During the choreography of one of his thematic works on God Shiva's Panchavaktram (the five-face person), Guru Nagaraja uttered this statement in an interview, "This intrigued me and as I researched deeper into the topic I was able to paint a mental picture of each of the five forms of God Shiva. All I had to do after that was to manifest this mental image on stage through the dance, costumes, and lighting" (Nair 2022). As an Indian classical dance artist gets more and more connected with the divinity and spirituality of the performance, whatever else occurs is of little or no interest. This includes injury, discomfort, or pain. For once the dancers enter the stage of developing the mental pictures

described by Guru Nagaraja the divine connection is all-powerful.

According to the dancers, suffering is an important element in order to become a polished and successful performer (Soundy and Lim 2023). When it comes to suffering and pain, it can be bifurcated into the categories of good and bad pain, where the former refers to the pain related to the focus on strengthening and training of the muscles. Experiencing good pain makes you more pain tolerant. Bad pain refers to the circumstances based on obvious injury such as the pain from a burn. Bad pain is associated with having no preparation for the unexpected situation (Tarr and Thomas 2011; Tarr and Thomas 2021). A dancer reveals that if there is no pain suffered then there is no effort put in—as stated by Markula, P and cited by (Soundy and Lim 2023). This indicates that even though the dance performers do experience pain they take pride in themselves and understand this pain as an achievement. This shows their high pain tolerance but at the same time it also leads towards the health-based ignorance behavior of the dancers.

The existing literature accepts that the dancers continue performing no matter what circumstances prevail, ignoring the acute injuries —as stated by McEwen, K and cited by (Soundy and Lim 2023). This shows the casual attitude toward injury and risky behavior of the dancers. Another aspect is if the dancers do pay attention to their pain and injuries, then they might be limited by medical advice which will not let them perform. This means a failure to the performer. The studies show that even though rest was a mandatory part of medical advice in order to heal faster, the dancers wished to perform for the scheduled show by suffering through the pain (Soundy and Lim 2023). This attitude might affect the dancers in the long run with more serious, even permanent, musculoskeletal issues.

Our hypothesis that, “The spiritual connection among Kathak dancers allows for high pain tolerance leading towards the ignorance of injuries ultimately affecting them in the longer term”, turns out to support the published evidence. Kathak dancers should be aware of the fact that despite high pain tolerance, ignoring the pain or injuries might affect them in the future. Therefore, they should focus on their positive approach toward pain tolerance by seeking medical advice and undergoing routine checkups so that minor injuries do not lead to permanent physical and spiritual damage.

Exploring the prevalence of back and lower extremity musculoskeletal injury among Kathak dancers

Analyzing Back Injuries and their prevention among Kathak Performers

According to the study conducted by Nair and colleagues (Nair et al. 2018), musculoskeletal pain is the major experience that Indian dancers undergo during professional life, constituting 73.5% of all complaints. Back pain is the most common of all the injuries suffered (Evans et al. 1998; Leanderson et al. 2011; Nair et al. 2018; Nilsson et al. 2001; Shah et al. 2012), approximately 17% of the total injuries occurring at the lower region of the body occurs at the low back and pelvis region, as per the data provided by Alvin American Dance Center (Ojofeitimi and Bronner 2011). Factors like extreme tilt of the anterior pelvic region, rigidity of back extensor muscles and less strengthened core muscles can be blamed as primary causes behind the reported occurrence of back pain among professional classical dancers (Khan et al. 1995; Kline et al. 2013; Micheli 1983; Rickman et al. 2012).

There are several possible themes for prevention that emerge from this examination

of the factors that may lead to the musculoskeletal injuries. These are:

- A. **Core strength exercises must be encouraged:** The abdominal and back muscles should be strengthened as they are the prime support to the spine as well as in maintenance of the posture.
- B. **Environment and flooring:** Hard floors are always related to bad health consequences. They can be replaced with a sprung floor to reduce the direct impact on the joints especially at times of intense movements like the chakkars.
- C. **Proper technique and form:** Ensure that the execution of the movements is done with proper form else, it would create and generate stress on the spine.

Analyzing Hip Injuries and their prevention among Kathak Performers

Indian classical dancers have often reported pain around the hip area, especially the dancers who perform Bharatanatyam dance form, as conducted by the survey (Anbarasi et al. 2012). Often the dancers undergo injuries due to the sudden stretching when movements are performed that involve hip flexion and the extension of knees, reportedly this occurs during the excessively performed motion (Askling et al. 2002; Askling et al. 2006; Askling et al. 2007; Askling et al. 2008) (Figure 4A). If we observe the anatomy of a human body, the stabilizers of the pelvis area are the adductors, including adductor longus, adductor brevis, adductor magnus, and gracilis when combined with the abdominals. If during the practice or performance the dancers experiences any inconsistency or imbalance among these muscles, then there may be an injury. Repeated inconsistency may result in a chronic dysfunction (Deleget 2010). According to a previous study, greater energy is required among professional dancers to

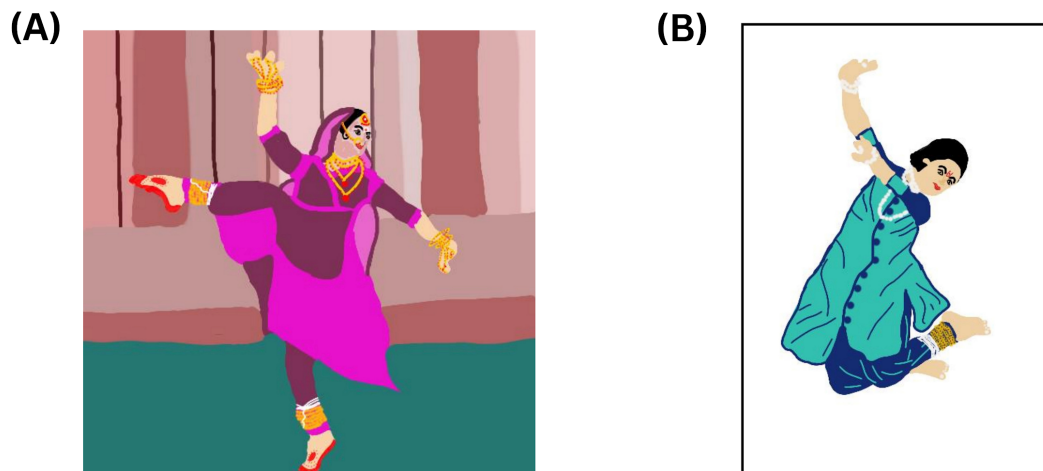


Figure 4 (A) Illustration capturing a posture performed by a female Kathak dancer with a high probability of becoming imbalanced as the complete weight of the body is upon one single leg. The female dancer is in complete Kathak attire known as Angarakha and churidaar pajama along with sets of jewelry like bangles, necklaces, nose-ring and forehead ornament. Ghungroos are tied on the ankles and a red dye called Alta or mahawar is applied on the dancer's feet.

(B) A jump element is illustrated here. The angle of the body matters and usually this jump is so high that if not done in an articulated and correct manner the landing may create problems related to the lower extremity, ultimately affecting long-term health. (Original creation by co-author ASD).

enhance the flexibility component (Harley et al. 2002). Quadriceps strains are occasionally observed among dancers. The reason behind this can be the enhanced flexibility of the body, although the Kathak dancers can be susceptible to this while performing the jump-based movements (Figure 4B). The jumping movement in Kathak itself requires proper coordination along with the landing skills which involves stretching, especially during the tihais (a rhythmic pattern that involves the repetition of the phrase in a set of three) (Figure 5B). With practice, the dancers achieve an incremental gain of flexibility, in turn elongating muscles. This initially requires proper guidance by the guru (dance teacher) with a gradual initiation.

The adolescent age, specifically between 14 and 16 years is the age group where most of the lateral snapping hip injuries occur (Winslow and Yoder 1995). “Snapping hip is a condition in which you feel a snapping

sensation or hear a popping sound in your hip when you walk, get up from a chair, or swing your leg around. The snapping sensation occurs when a muscle or tendon (the strong tissue that connects muscle to bone) moves over a bony protrusion in your hip” (Alaia 2020). One possible reason behind this could be the continuous interaction of soft tissues and tendons around the hip joint among dancers undergoing the adolescent phase, which leads to the changes in the musculoskeletal system as well. A study reveals that lateral hip pain is experienced by almost 30% of the dancers studied (Ireland et al. 2003; Mascal et al. 2003). In the context of Kathak dance, intricate movements involving the hip joint, for example twists and leg extensions, are common and repeated. In the long run, such movements may potentially result in friction between the tissues and tendons around the hip causing the snapping sensation.



Figure 5 (A) Shown here is a part of toda, i.e, the set of general syllables that starts from first beat called Sam and after two or more repetitions comes back to the first beat. Here, the performer is wearing the other outfit of Kathak, the Ghagra (a long skirt), choli (blouse) and an odhni (veil)
 (B) Image depicting a Kathak dancer in stationary position just after performing the tihai (rhythmic segment comprising three identical sections) with grace. (Original creation by co-author ASD).

There is a relationship between hip injuries and pain in other regions of the leg. Patellofemoral pain, for example, occurs due to the inadequate strengthening of hip abductors (Ireland et al. 2003; Mascall et al. 2003; Zazulak et al. 2007). Due to suffering from patellofemoral pain, the Kathak dancers may undergo a limited range of motion and, if imposed in excessive manner, can result in altering the dance techniques of the performance. The complex biomechanics and functional relationship between knee and hip joints make either of them affected if a dancer suffers from patellofemoral pain. In a nutshell, it can be stated that dancers may experience weakness in specific muscle groups contributing to this kind of pain and the possible cause can be the biomechanical compensation in the hip region and pelvis created due to muscular imbalance (Liederbach and Richardson 2007).

A comprehensive approach can help in addressing the injuries around the hip. The

possible strategies that could be followed in these lines are:

- A. **Flexibility training:** Incorporating regular stretching as a part of warm up can help in the improvement of hip flexibility. This also ensures a broader range of motion especially during the palta (turns), tukda (a fixed rhythmic composition that starts with an opening phrase and ends with a tihai—the phrase played in parts of three) (Figure 5A) and taking the spinning turns (chakkar).
- B. **Injury screening:** The assessment of balance is a major aspect to keep under focus and the pre-examining can help on a regular basis. Professional guidance from the instructors and therapists can also be sought if a person gets a symptom or signal related to such types of pain or injuries.
- C. **Taking short interval/break between the practices:** A short break is considered as a healing and relaxing way to avoid injury, but if this break

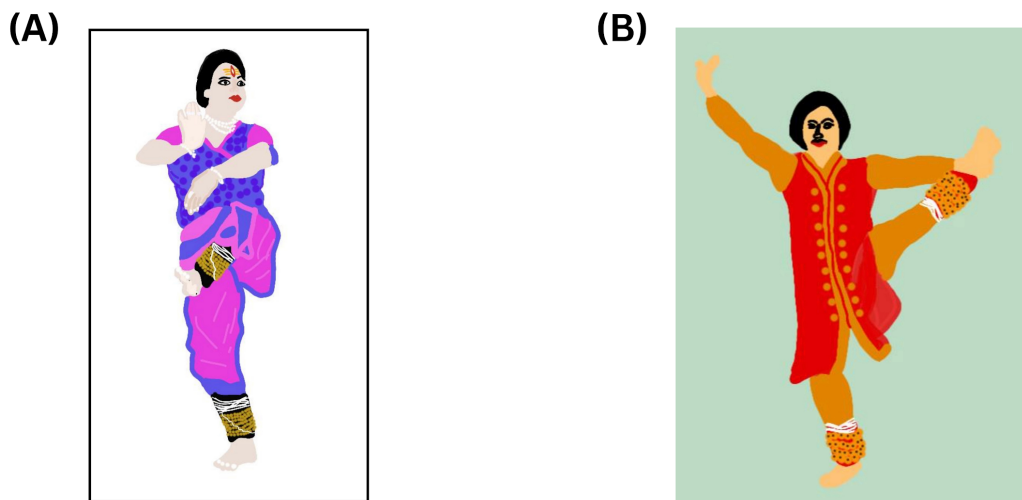


Figure 6 (A) An illustration depicting the stationary pose during Shiv tandava where the entire weight of the body comes on the left leg. This posture showcases Natraj—Indian God of Dance. (B) Captured within this frame is a glimpse of Shiv Tandava performed by a Kathak dancer. This can be counted as a part of a risky move as the body requires more motion and the lower extremity is involved in most of the performance, including the extreme stretching which may produce stress and contribute towards the injury. (Original creation by co-author ASD).

is taken for a long time, then this may lead to tiredness.

Analyzing Thigh Injuries and their prevention among Kathak Performers

When it comes to the dance-based thigh injuries, the few available studies report a prevalence of between 5% to 16% of all types of injury occurrences. These studies surveyed many types of dance genres. The most frequently occurring thigh injuries are hamstring strains (Laws and Apps 2005; Deleget 2010; Ojofeitimi and Bronner 2011).

When comparing athletes and non-athletes, dancers are found to have less strength in the thigh regions; according to the majority of the studies (Deleget 2010). Deleget proposed that dancers with especially weak thigh muscles and/or muscular imbalance have the greatest likelihood for injuries and will always be closer to their fatigue threshold (Figure 6A).

Among the students learning different types of dance performance, it was re-

ported that 51% of injuries were located in the posterior thigh area (Askling et al. 2002). Approximately 34% of these were chronic injuries and 66% were acute injuries. Askling and colleagues classified 88% of the injuries occurring due to slow stretching activities and 12% of the injuries occurring due to the high-speed activities. It is observed that frequently the dancers return to dance immediately after the injury, even while still suffering from the hamstring injuries. This type of injury is one where the dancers often ignore medical guidance (Askling et al. 2002). Even after experiencing an acute hamstring injury, less than half of the professional dancers chose to stop their physical activities (Askling et al. 2006). One review of the literature recommends that a closer examination of dancer's post-activity habits is required (Deleget 2010).

Standard medical advice is that it takes around 32 to 50 weeks to properly heal hamstring-based injury. But, most professional dancers and students estimate that

recovery takes merely one to two weeks, as an average (Askling et al. 2002; Askling et al. 2006). Though this shows the desire and dedication of the dancers and students, it also shows a lack of understanding of appropriate body functioning. This may lead to problems and concerns related to health in the future.

The literature review presented here may be used to suggest that certain precautions may be adapted by the Kathak dancers to minimize the risk of thigh-based injuries:

- A. **Awareness:** The fact that less than half of the professional dancers ceased physical activities after injury indicates that there might be a requirement for more awareness of injury prevention and post-injury recuperation among the dancers performing Kathak.
- B. **There should be a proper warm up:** It is always suggested to start the practice with a thorough warm up session. Dynamic stretches and movements can be included as a part of the warm-up to increase the blood flow in the muscles.
- C. **Build up intensity:** During training it is best to gradually increase both the intensity and duration of activity so that the muscles, mind, and spirit adapt to the process.
- D. **Proper cool down:** After the performance, more relaxed physical activity such as walking and static stretching can be included to cool down the body.
- E. **Education:** Prioritizing health-based education for the dancers is of utmost importance. Implementing a screening process for knowledge of past injuries, for problems with core control, and for muscular imbalance may help, as these factors may increase the risk of thigh injuries.

Analyzing Knee Injuries and their prevention among Kathak Performers

An understanding of the anatomy of the knee is crucial to comprehend the specific injuries that may occur in the knee as an outcome of dancing (Prakash 2016). Understanding muscle kinesiology at the knee joint is equally important. For example, some muscles are more actively engaged than others when it comes to performing movements that involve bending the knees (Trepman et al. 1998). In order to prevent injuries at the knee joint, the effective strategy is to enhance stability with the use of strengthening exercises. The major muscles to strengthen are the quadriceps, hamstrings and gastrocnemius muscles (Andrew 2003).

Among Indian classical dancers, knee injuries were observed as the second most prevalent type accounting for approximately 28.3% of all the total injuries (Suri 2020). One reason for knee injury is that Kathak dancers must sustain a position where the knees are bent and project beyond the toes. This position exerts strain on the knee joints, increasing the risk of knee injuries. As described in the doctoral dissertation by Prakash, while talking to a health expert it was mentioned that if the execution of this position is done in the proper manner, then the probability of suffering from strain, pain or injury can be lessened (Prakash 2016). However, the nature of Kathak dance involves jumps and changes in the acceleration rate of the body. With ground contact after a jump there are reaction forces that directly or indirectly impact the body and its joints (Anbarasi et al. 2012) (Figure 6B). The fluctuations in forces experienced at the knee joint are associated with the risk for pain and injury (Prakash 2016). If the quadriceps muscles are weak, then it is possible that there will be less engagement of muscles supporting

and more stress on the knee joint (Hart et al. 2010).

There is a lack of sufficient literature on knee injuries of dancers, but the following measures can be followed to prevent the injuries:

- A. **Strength training:** The focus must be kept on strengthening the quadriceps, hamstrings and calves so that these muscles contribute to enhancing the stability of the knee joints, especially during the rapid Kathak dance movements.
- B. **Technique awareness:** A proper training from the qualified instructor helps in shaping the alignment and posture correctly.
- C. **Engage in cross-training activities:** Yoga and swimming-like activities can contribute to improving flexibility and core strength which, in general, helps to maintain knee health.

Analyzing Foot and Ankle Injuries and their prevention among Kathak Performers

Considering various types of dance genres, a total of 34% of the lower extremity injuries occur around the foot and ankle area, as per the analysis of a 5-year long study performed by Alvin Ailey American Dance Center (Ojofeitimi and Bronner 2011). Another study on dancers reported that 23–45% of all the injuries to professional dances were to the foot and ankle (Kadel 2006). In Kathak dance, there is a consistent need to position and place the ankle in an unstable and uncertain manner (Chandan et al. 2018). According to a study, the emergence of high impact forces during classical dance results in modifications to the anatomical structure of the foot's arches. The continuous and elevated stress placed on the foot arches leads to the rolling of the ankle and foot (Masal and Borkar 2021). A majority of the reports suggest that overuse injuries

are most common contributors to ankle and foot-based problems (Chandan et al. 2018). As stated in a study conducted by Guruprasad and colleagues, the consistent foot tapping in Kathak is one of the factors that could be blamed for cramps and strain if performed without break (Guruprasad et al. 2019) (Figure 7A). During Kathak performances, the foot repeatedly undergoes extensive dorsiflexion and plantarflexion movements, resulting in a major strain on the respective linked muscles due to their extreme usage. Dorsiflexion is required to align the ankle to the appropriate and optimum stability (Donatelli 1985). The probability of injuring the ankle mortise (the joint composed of the tibia, fibula and talus bones) is increased when landing from a jump during the chakkar (spin around) to a position with the foot in a plantar-flexed and typically inverted position. The relaxation of all the muscles is responsible for plantar flexion and the complete plantar flexion results in the loosening of the collateral ligaments in the ankle (Neumann 2017).

Kathak dancers engage in high rotation-based movements of their body during chakkars. During this movement the heel serves as a pivot point and there is dorsiflexion of the ankle (Sabharwal and Singh 2017b). The left heel is most often used during the chakkar and, generally, the left leg of Kathakers possesses greater strength than the right leg. While there is a strength imbalance between the legs there is also better stability for the body when executing the typical chakkar (Kulshreshtha et al. 2022). Even so, the combination of dorsiflexion and external rotation generates more chances for the ankle to lose stability (Sabharwal and Singh 2017a). In addition, the frequent repetition of many Kathak dance postures, during the hours of either practicing or performing, results in left-right imbalances of ligament tension-relaxation, muscle strength, and ankle

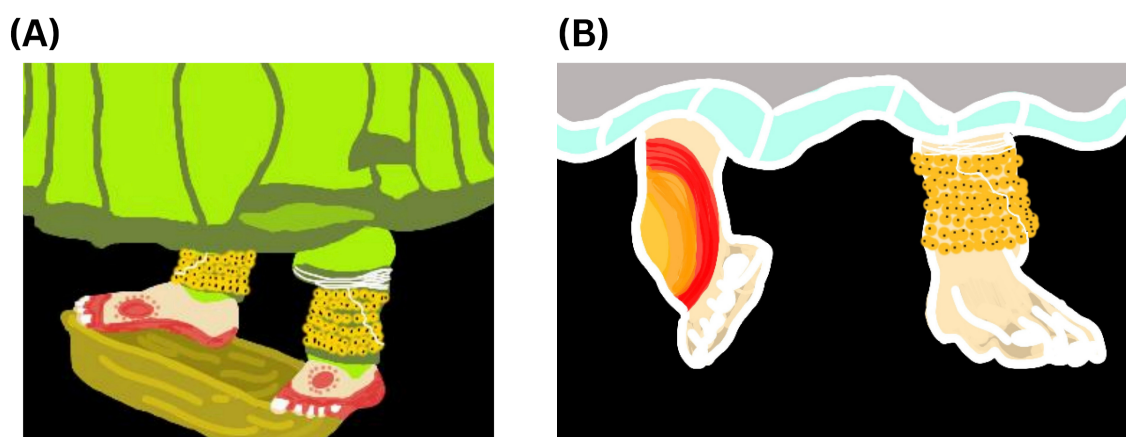


Figure 7 (A) Image depicting a sudden twist during a transition of movement amid the performance. This portrays an acute sprain which generally is neglected by Kathak performers. Such sprains can lead not only to immediate pain but severe long-term injuries as well.

(B) Figure illustrating a disbalance during the performance when a piece of jugalbandi (entwined twins) is performed. The performer is standing on the thali, a brass plate, and such segments if not done under proper training can result in direct or indirect injury. (Original creation by co-author ASD).

instability. The outcome is the dancers become prone to suffer injuries (Sabharwal and Singh 2017a).

One of the studies also claims that in one type of chakkar, known as bharamaris (turnouts), the foot is rotated while keeping it in a plantar-flexed position; this causes the ankle mortise to widen, resulting in the talus rotating externally which can lead to injury (Lin et al. 2006). Another study reported that the majority of the Kathak dancers are not aware of the correct way of placing the ankle (Hertel et al. 2002) ultimately leading to injuries (Figure 7B). Dancers should undergo a regular foot assessment so as to gather knowledge regarding foot pronation issues. One study reveals that dancers may encounter pronated foot conditions leading to musculoskeletal problems throughout their dancing careers. The body's anatomy and physiology are all connected and if any part of the lower extremity, for example the foot faces any issue, then consequently it will impact the

knees (Chandan et al. 2018). A special risk for Kathak dancers comes from wearing heavy ankle bells and dancing barefoot (Anderson 2001). To compensate for this the dancers require flexibility and correct postural angularity for the support of foot and ankle (Evans et al. 1998; Kadel 2006). Prevention of the ankle and foot-based injuries is crucial for the Kathak dancers, and the following measures can be adapted:

- A. **Awareness of ankle and foot alignment:** The alignment, if done in a proper way, can reduce unnecessary stress on the joints and ligaments.
- B. **Avoid dancing through pain:** The discomfort around the ankles and feet is a signal towards the occurrence of injuries although many dancers ignore this considering it as a minor pain. The dancers should learn to recognize the pain and immediately stop at the moment pain occurs.
- C. **Injury prevention workshops:** Healthcare professionals and the dance in-

structors should conduct educational programs and workshops based upon this issue (Table 1).

In addition, ankle and foot injury prevention may be prevented by following our general hypothesis #1: The occurrence of lower extremity musculoskeletal injuries is reduced when a Kathak dancer incorporates consistent warm-up and stretching during the practice session along with suitable training related to the strengthening and conditioning of the lower extremity (Table 2).

Limitations

The study is limited to the exploration of the back and lower extremity injuries among Kathak dancers. Further research is needed to understand the association of body physique and composition of male and female dancers with risk for injury and injury type. This study only includes dancers who are facing injuries at present time. The study does not focus on people who quit dance due to these injuries in the past. The current study is based on secondary data and in the future researchers collecting primary data should compare our findings with their own.

Table 1 Risk of injuries in Kathak dance, indicating the different types of movement, the muscles/tendons used in a particular movement, the cause of injury for that movement and the prevalence of the injuries.

TYPE OF INJURIES	TYPE OF MOVEMENT	MUSCLES/TENDON USED	CAUSE OF INJURY	PREVALENCE
Back Injuries	Swinging	Extensor Muscles	Extreme tilt of the anterior pelvic region Rigidity of back extensor muscles Less strengthened core muscles	17%
Hip Injuries	Hip flexion Extension of knees	Adductor longus Adductor brevis Adductor magnus	Twists and leg extensions Snapping hip Continuous interaction of soft tissues and tendons around the hip joint.	30%
Thigh Injuries	Medial (internal) rotation	Hamstring muscles	Slow stretching High-speed activities	5%–16%
Knee Injuries	Flexion	Quadriceps muscles Hamstring muscles Gastrocnemius muscles	Kathak dancers must sustain a position where the knees are bent and project beyond the toes. This position exerts strain on the knee joints, increasing the risk of knee injuries.	28.3%
Foot and Ankle Injuries	Dorsiflexion Plantarflexion	Tibialis anterior Extensor Digitorum longus Extensor Hallucis longus	Overuse injuries Consistent foot tapping in Kathak is one of the factors that could be blamed for cramps and strain if performed without break.	34%

Discussion and conclusion

To the best of our knowledge, this is the first comprehensive narrative review of the back and lower extremity musculoskeletal injuries of Kathak dancers. Our review is enhanced by relating the risk for injury with the spirituality element of Kathak dance. Our review finds that there is limited published information available on this topic—only 42 sources met the inclusion criteria. There are some differences and inconsistencies between the findings of the reviewed materials. Variations in the interest of the researchers (sport physiology, artistic dance, religion/spirituality) and in the type of publication (scientific journals, dance magazines, news stories) are likely to be some of the reasons for the diverse findings.

A focus by practitioners on the spiritual/religious nature of Kathak dance places them at risk for physical injury. The lack of awareness regarding minor lower extremity musculoskeletal injuries among Kathak dancers can result in major impairment and in poor health. Kathak Dancers

should be aware that if they suffer from an acute pain during their practice session, they must not ignore it and should seek medical advice. There is an essential requirement for developing supplementary exercise training programs for practitioners. Cross-training activities such as Yoga and interventional occupational awareness programs for health can be arranged to ensure their good health. The proper warm-up before the session and cool down exercises after should be implemented as a routine practice, along with choosing the correct nutrition and diet. Kathak dancers are resilient when it comes to spiritual and mental aspects which is a positive sign, but their attitude of neglecting the pain and injuries indicates that in a long run it may impact the muscles and the skeleton contributing towards poor health. Therefore, there is a need to develop programs creating self-awareness among dancers regarding this issue and motivate them to seek the necessary supplementary training programs and medical attention before it is too late.

Table 2 Preventive measures for different type of injuries.

TYPE OF INJURIES	PREVENTIVE MEASURE
Back Injuries	Core strength exercises must be encouraged Environment and flooring Proper technique and form
Hip Injuries	Flexibility training Injury screening Taking short interval/ breaks between the practices
Thigh Injuries	Awareness There should be a proper warm up Build-up intensity Cooldown
Knee Injuries	Strength training Correct technique awareness Engage in cross-training activities
Foot and Ankle Injuries	Awareness of ankle and foot alignment Avoid dancing through pain: The dancer should learn to recognize the pain and immediately stop when pain occurs Injury-prevention-workshop

Data availability

All data and literature sources used for this article are available from the authors.

Authors' contributions

Conceptualization (lead), writing – original draft (lead), digital illustration and figures (lead), methodology (lead), writing – review and editing (equal): Abhijeet Singh Dewari; Conceptualization (supporting), writing – review and editing (equal), supervision (supporting), methodology (supporting): Barry Bogin; Supervision (lead), writing – review and editing (equal): Shivani Chandel

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