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Balance comparison between female Bharathnatyam dancers and active non-dancers: A pilot study

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Abstract
Dance is considered as a sport due to its movement related skills and motor skills. Dance being a special expression of human beings motor behaviour, during dance individuals have the opportunities to execute several movements which amount to exercise. Studies suggest that Bharathnatyam dancers have better balance because they use a lot of movements in different stances. Hence the objective of this study was to compare the balance between Bharathnatyam dancers and active non- dancers. A pilot study was conducted on 20 female Bharathnatyam dancers and 20 age matched female non- dancers between 18 to 35years of age. Static balance was assessed using Balance Error Scoring System (BESS), and dynamic balance was assessed using Star Excursion Balance Test (SEBT). Static and dynamic balance scores of two groups were compared using independent sample t test; it was found that the difference in p value for BESS and SEBT scores between the groups were less than 0.00, indicating a significant difference in balance between the groups. The study concluded that female Bharathnatyam dancers possess better balance abilities as compared to age matched active non-dancers. Further studies can assess whether these balance abilities transfer to daily life activities.

Keywords: Bharathnatyam dancers, active non-dancers, dynamic balance, static balance

1. Introduction
Dance is considered as a sport due to its movement related skills and motor skills. Dance being a special expression of human beings motor behaviour, it is the art of reflecting self-explanation through movement. During dance individuals have the opportunities to execute several movements which amount to exercise. Benefits of dance for humans as a sporty tool has been investigated by many studies. The essential physical qualifications for dance are strength, flexibility, endurance, balance and coordination. Being the most aesthetic and rhythmic way of movement, dance is a technological and complex activity that contains exercise which strengthen the musculoskeletal system as well as improves balance and coordination, by enabling the body to move freely in space and time [1].

Balance can be defined as the ability to maintain the body's centre of gravity over its base of support with minimal sway or maximal steadiness [2]. Balance abilities can be divided into static and dynamic components. Static balance is defined as "the ability to maintain a posture such as balancing in standing or sitting," and dynamic balance is defined as "the ability to maintain postural control during movements such as reaching for an object or walking on various surfaces" [3, 4]. Stability maintenance is a dynamic process that needs continuous processing of sensory input from visual, vestibular and proprioceptive receptors in order for one to supervise the other. There are many factors that interfere with normal balance [5]. This includes age of an individual, disease state, developmental or postural disorders such as scoliosis, kyphosis, variability in movements, and overweight, etc.

Stability specifically relates to a dancer's ability to maintain balance. When the base of support is large, a dancer is very stable, yet whilst balancing on point a dancer is easily disrupted from the position and therefore highly unstable [6]. Balance is achieved when the centre of mass and base of support are aligned vertically, whereas stability is a measure of how difficult balance is to maintain. Greater stability is achieved when the base of support is large and the centre of mass is lowered. A larger base of support means that the area over which the centre of mass will fall is enlarged. When the centre of mass is lowered, stability is more easily sustained because the body has less potential energy when the centre of mass is closer to the earth's core [7, 8].

Bharathnatyam is an Indian classical dance form which has different postures and poses. A performer needs to elegantly maintain balance throughout the performance. The different body movements called Karanas are beneficial to improve balance, while performing Karana a performer needs to stay in one posture or a few seconds. The posture can be compared to standing on one foot for few seconds without losing balance [9]. In this dance form hand gestures and facial expressions are used to communicate and express feelings. The Mudras provide work out for various body parts and improve flexibility [10, 11]. Practicing Bharathnatyam can give all the benefits that aerobics provides. Dancing is good for overall physical fitness. The rapid body movements in this dance form boost blood circulation. Bharathnatyam makes the body and mind agile. A performer needs to remember steps, names of the various steps, different moves, the beats and rhythm of the song. With all this a dancer has to pay attention if the body movements are in sync. This hones the mental skills and builds mental alertness [12, 13].

Araimandi is the most basic of Bharathnatyam dance, which is similar to demiplie position used in the ballet. This dancing posture has a closed chain knee flexion with hip abduction and external rotation. To maintain the balance (stability), dancers need adequate flexibility in their lower extremity muscles. The term flexibility is the range of motion to joint through its normal plane of motion and static flexibility is the range of motion available to a joint or series of joints. The dynamic flexibility refers to the ease of movement within the obtainable range of motion. Muzhumandi is another pose where knees are completely bent and body is balanced on toes and heels are raised [14, 15]. There are various such positions in Bharathnatyam to attain which dancers need optimal muscle strength and adequate motion at the required joints. Bharathnatyam makes use of this principle to provide the dancer with increased stability and balance. The population of dancers is unique because they are not merely athletes whose work intensity is no less than a football player but also they are artists who constantly strive to perfect the subtle and aesthetic details in performance [16].

Several studies have indicated better balance control in dancers than in control participants [17, 18] However, it has been argued that the specialized balance training received by dancers may only have an effect during challenging balance conditions, and may not transfer to less challenging balance conditions that are more representative of everyday life [19].

Studies have been done to compare balance between dancers and athletes, classical dancers and free style dancers. Most of these studies have concluded that dancers have better balance, and these balance abilities have a protective effect over lower limb injuries in dancers. To date, only a limited number of studies have been done to compare balance between classical dancers and active non-dancers. Hence this study was designed to compare static and dynamic balance between Bharathnatyam dancers and active non-dancers.

2. Materials and Methods

A Pilot Study was conducted on 20 female Bharathnatyam dancers and 20 age matched female active non-dancers for 3 months. A convenience sampling technique was used to include the participants in the study. Ethical clearance became received from the institutional ethical committee. The subjects were enrolled according to the inclusion and exclusion criteria. The inclusion criteria were professional Bharathnatyam dancers with more than 5 years of experience and active non-dancers who did not have dance training, willing to participate in the study, able to understand instructions and with good visual acuity (6/6 with or without correction). The exclusion criteria were those who had history of chronic ankle sprains, recent musculoskeletal injuries, neurologic or vestibular dysfunction, chronic pain, those who had undergone surgery to lower extremity within three months of data collection and those who had consumed alcohol or taken medications within 12 hours before testing. This study involved minimal equipment such as a rigid surface, foam pad, a stopwatch, Measuring tape, and pen/pencil, Paper.

2.1 Procedure

The purpose of the study and brief introduction to the test procedure was explained to the participants. Demographic and anthropometric data was collected once the informed consent was signed. The test procedure was demonstrated to avoid compensatory activities. The participants were screened for Star Excursion Balance Test (SEBT) and Balance Error Scoring System (BESS) to assess dynamic and static balance respectively. Each participant performed SEBT two practice trials followed by three data collection trials. Collected data was tabulated for statistical analysis.

2.2 Outcome Measure

To assess static balance and dynamic balance of female Bharathnatyam dancers and active non- dancers Balance Error Scoring System and Star Excursion Balance Testing were used respectively.

2.2.1. Balance Error Scoring System

The Balance Error Scoring System (BESS) is used to measure static balance. The BESS required participants to stand in six different conditions. The testing conditions included three stances (double leg, single leg, tandem) on two surfaces (stable, rigid floor and unstable, foam pad). The BESS has acceptable to excellent reliability between 0.50 and 0.88 [20]. Participants performed each condition with eyes closed and hands on hips for 20 s. The BESS score was determined by the number of errors recorded, with a lower score indicating better. The BESS errors included (1) opening eyes, (2) lifting hands from hip, (3) touchdown of non-stance foot, (4) step, hop, or other movement of the stance foot or feet, (5) lifting forefoot or heel, (6) moving hip into more than 30 degrees of flexion or abduction, and (7) remaining out of position for longer than 5seconds. Each participant performed two practice trials followed by three data collection trials, with the mean score used for statistical analyses.

2.2.2. Star Excursion Balance Test

The Star Excursion Balance Test (SEBT) is a tool to assess the dynamic balance of healthy people and athletes. The Star Excursion Balance Test (SEBT) incorporates a single- leg stance with a maximum reach of the opposite leg. The SEBT has acceptable-to-excellent reliability between0.84 and 0.92. Participants performed the SEBT while standing at the centre of a grid placed on the floor, with eight lines extending at 45 degrees' increments from the centre of the grid. The lines positioned on the grid were labelled according to the direction of excursion relative to the stance leg: anterolateral, anterior, anteromedial (AM) medial (M), posteromedial (PM), posterior, posterolateral, and lateral. Because previous research suggests that the AM, M, and PM directions are the most sensitive to detect balance abilities, we tested these three directions. Participants lightly touched the furthest point

possible on the line with the furthest part of the reach leg while maintaining balance [20]. Participants then returned to a bilateral stance while maintaining equilibrium. The distance from the centre of the grid to the touch point was measured, with greater reach distances indicating better balance. Each directional reach was practiced six times, followed by three testing reaches that were averaged for statistical analyses.

2.3 Statistical analysis
Demographic characteristics of the participants based on age, analysis of the demographical data was detailed by descriptive statistics i.e., mean, standard deviation and frequency was used to describe participant's characteristics. The collected information about static and dynamic balance of participants summarized by using mean and standard deviation. Independent sample t test was used to test the significance difference in the static and dynamic balance outcome measures between the two groups. The 'p' value less than 0.05 was considered significant. The data was analysed using the software SPPS version 20.

3. Results
In this cross sectional study, 20 Bharathnatyam dancers and 20 age matched active non-dancers were participated. The mean ages of the two groups were 24.6250, with the standard deviation of 1.45317 (Table 1). Bharathnatyam dancers had significantly fewer errors than did non-dancers on the BESS. Bharathnatyam dancers had overall higher SEBT reach distances compared with non- dancers. There is a significant difference found in the static and dynamic balance between Bharathnatyam dancers and active non- dancers.

Table 1: Comparison of BESS scores and SEBT scores in Bharathnatyam dancers and active non- dancers

Variables	Dancers Mean ±SD	Non-dancers Mean ±SD	t - value	p- value
BESS*1	11.40±3.11*	20.50±2.94	-9.85	0.000
SEBTM*2	90.33±2.64*	85.34±2.84	5.739	0.000
SEBTP*3	95.22± 1.55*	82.12± 0.79	33.62	0.000
SEBTA*4	91.27 ±2.16*	85.67± 2.55	7.42	0.000

*Indicates significant difference between dancers and non- dancers. *1 Balance error scoring system, *2 Star excursion balance testing in medial direction, *3 Star excursion balance testing in posteromedial direction, *4 Star excursion balance testing in anteromedial direction

4. Discussion
This cross sectional study was designed to compare static and dynamic balance between professional Bharathnatyam dancers and active non- dancers. The study was carried out on 20 female Bharathnatyam dancers and 20 age-matched active non-dancers, aged between 18 years -35 years. The dynamic balance in both group were measured using Star Excursion Balance Test (SEBT) and static balance were assessed using Balance Error Scoring System (BESS). It was found that professional Bharathnatyam dancers had better balance abilities than active non- dancers who were age matched. The study found strong significant difference in the balance between the groups.

The novel findings of this study was that Bharathnatyam dancers showed increased static and dynamic balance as compared to active non-dancers. Dancers utilize various poses for a depiction that have a unilateral stance, balancing on the toes in full squatting (Mandi pose), and quick changes in posture that require rapid weight shifts. Different steps require movements in and out of the base of support with different upper and lower limb movements, in turn causing continual shifts of the centre of gravity while dancing.[16]These findings are consistent with previous studies [22, 23, 24, 25]. It appears that dancers have better sensory motor integrative skills as measured by their superior performance on complex balance task.

Bharathnatyam dancers undergo vigorous training in all the various aspects of the art form. Bharathnatyam dance incorporates a lot of one leg positional holds (for poses), spins (single-legged or double), pivot turns, quick movement transitions, changes in positions and stances ('araimandi', 'mandi', lunge positions, full sit, side sits etc.). This may explain their better performance in tests of static and dynamic balance [16].

Differences in balance skills have been found between non-specialized control participants and other subject groups such as soccer players, gymnastics and acrobats. It has been identified that dancers have certain standing balance abilities that are better than those of other subject groups [26, 27, 28].

Some evidence is available in the literature demonstrating that trained dancers exhibit better balance abilities as well as postural control as compared to other physically active population. Kiefer *et al*. in their study assessed postural coordination among female ballet dancers and athletes during static and dynamic tasks and found that since dancers are trained to look for reference points during gesture movements, they presented more control, as well as more stable hips and ankles when compared to athletes [29]. Cheng HS *et al* found that dancing exercise results in better postural stability and less visual dependence on postural control in adolescent females [30]. Liederbach *et al* reported dancers are more resistant to lower extremity fatigue than athletes, and this may partially explain the lower incidence of ACL injuries in both male and female dancers compared to team athletes. The extensive training in landing technique and daily practice that dancers undergo from a young age may be responsible for the higher levels of endurance [31].

The SEBT measures an individual's ability to move in a controlled manner while maintaining a stable unipedal stance grid [20]. In our study dancers demonstrated greater SEBT scores in all the three directions than the active non-dancers. A study done by Ambegaonkar *et al* in dancers and active non-dancer showed that dancers exhibited better balance than did non-dancers. Specifically, dancers demonstrated better scores than those of non-dancers or BESS and for two of the three SEBT test directions (M and PM) [32]. In our study dancers reached further in the M, PM and AM directions. The reason for this observation may be that while our dancers may have had some practice moving in these directions during dance participation, non-dancers likely did not often move in these directions. Consequently, the non-dancers' M, PM and AM reaches were lower than the dancers' reach.

In contrast to the findings of the present study Janura *et al* demonstrated that professional ballet dancers do not possess better balance abilities than untrained subjects and that they would perform better particularly under conditions with high

demands on postural control [33]. Similarly Perrin *et al*. found no differences between dancers and controls in eyes-open conditions, although judoists performed better than dancers in this condition. Moreover, inferior performance was observed in dancers relative to both groups in eyes-closed conditions [34].

Comparing our findings with previous reports in athletes, it appears that although dance participation results in dancers having better balance than that of non-dancers, dance participation is not superior to athletics participation, at least where balance is concerned. In fact, some athletes (judoists) reportedly have better balance than that of ballet dancers. Accordingly, movement demand differences between dancers and athletes might also partly explain the ACL injury rate disparity between dancers and physically active individuals and athletes [34].

Our study results have future implication in the scope of regular practice of dance in enhancement of balance in females. Our study draws the attention to the benefits of dance in several aspects, balance in particular. Some previous studies also have found that dancers exhibit greater balance abilities than active non-dancers. Dance plays a vital role in overall wellbeing of our body, dance practice can be considered as a tool to improve balance.

5. Limitations of the study

Our study involved a small group of dancers and non-dancers, only female participants were included in this study. So it is very difficult to generalize the results of this study to whole dancers' population as it involves both male and female dancers. This study focused only one dance form, other styles of dance can also be considered. Our study was done only on younger population, so it is important to find out the balance abilities of dancers and non- dancers in other age groups**.**

6. Conclusion

The results of the current study demonstrated that female Bharathnatyam dancers possess better balance abilities as compared to age matched active non-dancers. Dance practice over an extended period can improve static and dynamic balance. These findings may encourage non-dancers to explore the benefits to be derived from incorporating dance practice in daily life

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