

Assessment of Lower Limb Flexibility in Female Bharatanatyam Dancers

Jyothi S^{1,*}, Sujaya B²

ABSTRACT

Background and Aim: Bharatanatyam is one of the Indian classical dance forms. Aramandi which is similar to Demi plie position of ballet dancers and Muzumandi are the commonest poses in this dance form. Attaining these poses requires adequate range of motion at the joints and so flexibility is considered as an essential element of normal biomechanical functioning in dance. The objective of the study was to assess the range of motion at hip, knee and ankle joints using goniometer and compare the results between dancers and non-dancers. **Methods:** Thirty-two bharatanatyam dancers and 33 non-dancers in the age group of 18-23 years participated in this study. The range of motion for different movements at hip, knee and ankle joints was assessed using goniometer. Data obtained was expressed as mean±SD and independent t test was used to compare the data. **Results:** Dancers had a significantly higher range of motion for flexion (P=0.002) and abduction (P<0.001) at hip joint. Range of motion for external rotation was higher in dancers than non-dancers but not statistically significant. **Conclusion:** This study showed that dancers had higher range of motion for some movements at hip joint but flexibility did not differ from non-dancers at knee and ankle joints. Additional physical training techniques can be employed to improve the flexibility which will reduce incidence of injuries and improve performance.

Key words: Bharatanatyam, Flexibility, Goniometer, Range of motion, Lower limbs.

INTRODUCTION

Bharatanatyam is an Indian classical dance form. It involves rhythmic dance movement (Nrittha), dance in dramatic aspect (Natya) and combination of both (Nrithya). There are various types of abhinayas of which Angika is physical or body movements. Aramandi is the most basic position in bharatanatyam which is similar to Demi plie position of ballet dancers. Here knees are flexed and there is abduction and external rotation at hip joints.^[1] Muzumandi is another pose where knees are completely bent and body is balanced on toes and heels are raised. There are various such positions in bharatanatyam to attain which dancers need optimal muscle strength and adequate motion at the required joints. 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.^[1] There are huge number of professional dancers and countless amateur dancers or recreational dancers and they are a unique group of athletes with aesthetic nature of sport.^[2] In dancers, high incidence rates of musculoskeletal injuries have been reported mainly in the lower extremities and back, predominantly soft tissue lesion and overuse injuries. Various potential risk factors for dancers have been suggested ranging from physical overload to psychological distress,

however, conclusive evidence of any reported risk factor is lacking.^[3] Flexibility is considered as an essential element of normal biomechanical functioning in sport. Lack of flexibility may lead to produce early muscle fatigue or alter the normal biomechanics of movement predisposing to injury. The literature report shows a number of associated benefits of flexibility including improved athletic performance, reduced injury risk, prevention or reduction of post exercise soreness and improved co-ordination.^[1] Flexibility of the lower limb that is the lower extremity range of motion (ROM) may also influence the reach distance in Star Excursion Balance Test (SEBT). The SEBT has become a widely used dynamic test for clinical and research testing purposes.^[4]

There is a huge lacuna in the area of dance medicine in relation to the Indian classical dance. There is a lack of research work done specifically on Indian classical dancers.^[1] The traditional practices of the dancers need to be carefully studied and juxtaposed with the modern system of physical training.

MATERIALS AND METHODS

Study Population

A comparative study was conducted to compare lower limb flexibility of dancers and non-dancers. Bharatanatyam dancers were randomly selected

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from various bharatanatyam dance schools in Bengaluru and non-dancers were selected from general population by convenience sampling. The approval and clearance from the institutional ethical committee was obtained before starting the study. The written informed consent was obtained from the subjects in the prescribed format in English.

Inclusion Criteria

Female bharatanatyam dancers in the age group of 18-23 years and those who had formal training in bharatanatyam for minimum of 5 years and currently practicing for at least for 6 hr a week were included in the study. Age and BMI matched normal healthy sedentary female subjects were recruited for the non-dancer group.

Exclusion Criteria

Subjects with history of injury in past 1 year, pregnant women and dancers with formal training and currently practicing dance forms other than Bharatanatyam were excluded from the study.

Procedure

History regarding the general health status was taken. Questions regarding practice of dance and sports activities were administered to all the subjects. Based on the answers to the questions given by the subjects and inclusion and exclusion criteria for dancers were included in the study. As described in the standard protocol of the test, time was given to familiarize with the test procedure for all the subjects. Height and weight were measured and BMI was calculated.

Goniometry was the test used to measure ROM at joints with the help of a goniometer which is a measure of flexibility of the joints. Range of motion at hip joint, knee joint and ankle joint were measured for the movements performed at these joints. Flexion, extension, abduction, adduction, external rotation (ER) and internal rotation (IR) were measured at hip joint. Flexion and extension were measured at knee joint. Dorsiflexion (DF), plantar flexion (PF), ER and IR were measured at ankle joint. Range of motion was expressed in degrees.

Statistical Analysis of Data

The data was expressed as mean ± SD. For comparison of range of motion between dancers and non-dancers, independent *t* test was used. *P* value <0.05 was considered statistically significant.

RESULTS

Table 1 describes the anthropometric data such as age, height, weight, BMI and lower limb length of dancers and non-dancers. As the participants recruited were age and BMI matched, there was no

significant difference in the age, weight and BMI. No significant difference was observed in other anthropometric data also. Table 2 explain the data related to years of learning dance and weekly practice hours of both dancers and non-dancers.

ROM at hip joint was significantly higher in dancers for flexion and abduction compared to non-dancers. Though ROM for other movement at right hip joint was increased in dancers when compared to non-dancers, it was not statistically significant (Table 3). There was no difference in ROM at right knee joint (Table 4). Dancers had higher ROM for plantar flexion, dorsiflexion and external rotation at ankle joint in comparison with non-dancers but the values were not statistically significant (Table 5).

DISCUSSION

Khan K, *et al.* compared hip and ankle range of motion in elite classical ballet dancers and controls and reported dancers had higher hip ER than controls. There was no difference in ankle DF in dancers and controls.^[5] Similarly, our study on bharatanatyam dancers showed higher ER at hip joint in dancers compared to non-dancers but it was not statistically significant and ankle DF did not differ significantly between dancers and non-dancers. Unlike our study, the above study involved both male and female ballet dancers. As ankle DF did not differ between dancers and controls, despite repeated training of these movements in ballet, there may be anatomical limitations to this movement.^[5] This was similar to our study where dancers and non-dancers did not show any significant difference for movements at ankle joint.

Hip and ankle ROM were assessed in 8-11 year old novice female ballet dancers and they had less ER and IR range than controls. The results of this study suggest that pre and peri-pubertal novice ballet dancers are not blessed with the much greater range of hip ER and turnout seen in elite dancers. This suggests that the greater ROM seen in both hip ER and turnout in older dancers must arise as a result of training or selection or perhaps a combination of both factors.^[6] They were followed up for 12 months. Both dancers and controls gained significant hip ER and IR. Ankle DF is largely fixed at this age and ballet teachers should ensure that range of motion is maintained.^[7] Unlike this study, bharatanatyam dancers in our study had no significant difference in hip ER and IR in comparison with non-dancers, while ankle DF results were similar to the above study. The most important reason for this difference is the dance style i.e., bharatanatyam and ballet which have different practice techniques.

On contrary to the above studies where 8-11 year old ballet dancers were assessed, our study involved bharatanatyam dancers of age group 18-23 years. Another study by Khan KM, *et al.* concluded that dancers aged 16-

Table 1: Comparison of anthropometric data between non-dancers and dancers.

Variables	Non-dancers group (n=33)			Dancers group (n=32)			Difference in mean	t value	P
	Range	Mean±SD	SE	Range	Mean±SD	SE			
Age	23-18	21.8±1.55	0.27	23-18	20.09±2.15	0.38	1.71	3.72	NS
Height	167-146	158.7±5.27	0.63	178-152	161.2±5.17	0.91	2.5	1.89	0.063
Weight	84-39	58.49±10.9	1.91	82-46	60.55±8.29	1.46	2.06	0.859	0.393
BMI	30.6-16.6	23.08±3.62	0.63	30.1-18.4	23.15±3.04	0.54	0.07	0.08	0.933
Lower limb length	100-78	86.48±5.63	0.98	100-80	89.03±5.06	0.89	2.54	1.91	0.06

NS: Not significant; BMI: Body mass index

18 years who enter full-time ballet training did not augment their ankle DF to any appreciable degree. Some, but certainly not all, increased their hip active external rotation over 12 months. Hip ER was more likely to improve in the first-year rather than second-year student in this elite full-time training school.^[8] Their results correlated with results of our study, it is because there may be bony formation of each joint that limits the improvement in the ROM. Unlike the above study, dancers did not have higher hip ER than non-dancers even though they have been practicing for a minimum of 6 hr per week for over 5 years. The change in dance style, training programme as well as the age group involved might be the reasons for this difference observed in our study.

A study by Steinberg N, *et al.* conducted a study on 1320 female dancers who participated in different types of dancing classes and 226 non-dancers, all aged 8-16 years. ROM was measured for the hip, knee, ankle joints. Hip ER, ankle PF, ankle DF showed no change as observed in our study. However, in contrast to our observation, Hip abduction was reduced in the above study. This study involved participants from different dancing classes like classical ballet, modern dance, jazz etc. Our study had only one type of dancers, bharathanatyam. Dancers and teachers should realize that passive range of motion is unlikely to improve with age and so the dancing programme should focus on exercises that retain the natural flexibility of the dancers joints' rather than trying to improve them.^[9]

In our study, we have measured ROM on right side since that is their dominant side. Ten non-professional ballet dancers (16-23 years old) were assessed to evaluate difference in ROM between right and left sides. There was a small difference between the right and left sides of the hip with respect to flexion and abduction, which suggest the dominant side of the subjects, which is not statistically significant. There was no imbalance between the sides of the hip with respect to active abduction and flexion movements in non-professional ballet dancers.^[10]

Most of the studies involve dancers practicing western dance forms and in most of the studies where flexibility is assessed by measuring range

Table 2: Mean years of learning and mean practice hours per week in dancers.

	Range	Dancer group	
		Mean±SD	SE
Year of learning	15-5	8.68±2.61	0.46
Practice in hours per week	8-6	6.31±0.53	0.09

Table 3: Comparison of range of motion at right hip joint between non-dancers and dancers.

Hip (Degrees)	Non-dancers group (n=33)			Dancers group (n=32)			Difference in mean	t value	P
	Range	Mean±SD	SE	Range	Mean±SD	SE			
Flexion	130-45	107.7±20.15	3.51	160-60	123.91±20.46	3.62	16.17	3.21	0.002*
Extension	20-5	9.84±2.33	0.41	20-5	10.47±4.28	0.76	0.62	0.72	0.469
Abduction	50-20	36.81±7.26	1.26	80-30	50±12.95	2.28	13.18	5.08	<0.001*
Adduction	50-15	35.61±7.78	1.35	50-20	36.87±80.21	1.45	1.27	0.64	0.525
ER	50-15	33.63±9.54	1.66	60-15	38.13±9.81	1.73	4.48	1.86	0.066
IR	60-10	32.73±11.86	2.06	70-15	36.41±10.64	1.88	3.68	1.31	0.193

* P value <0.05 was statistically significant. IR: Internal rotation; ER: External rotation

Table 4: Comparison of range of motion at right knee joint between non-dancers and dancers.

Knee (Degrees)	Non-dancers group (n=33)			Dancers group (n=32)			Difference in mean	t value	p
	Range	Mean±SD	SE	Range	Mean±SD	SE			
Flexion	150-85	120.91±14.9	2.59	150-70	128.28±18.3	3.23	7.37	1.78	0.0795

Table 5: Comparison of range of motion at right ankle joint between non-dancers and dancers.

Ankle (Degrees)	Non-dancers group (n=33)			Dancers group (n=32)			Difference in mean	t value	P
	Range	Mean±SD	SE	Range	Mean±SD	SE			
Dorsiflexion	80-15	30.91±14.38	2.5	50-20	36.56±9.71	1.71	5.65	1.85	0.068
Plantar flexion	50-10	25.3±8.37	1.45	40-10	27.18±6.46	1.14	1.88	1.01	0.315
ER	45-10	22.27±9.84	1.71	50-15	23.28±7.89	1.39	1.01	0.45	0.651
IR	40-10	22.42±10.16	1.76	40-10	22.18±6.71	1.19	0.23	0.11	0.912

IR: Internal rotation; ER: External rotation

of motion, only hip and ankle flexibility have been assessed unlike our study which also involves assessment of knee flexibility along with hip and ankle joints. Flexibility of the body is one of the most important physical attributes required for a dancer. Practices of spinal twists such as Ardha Matsyendrasana and Vakrasana, back bending poses like Laghu Vajrasana, Rajakapotasana, Chakrasana, Dhanurasana and forward bending asanas such as Padahasthasana, Pashchimottasana, Halasana ensure flexibility of the body. This makes the body supple and allows the dancer to perform movements effortlessly and gracefully while dancing.^[11]

There is lack of research on Indian classical dancers with respect to parameters such as balance, muscle strength and flexibility. Bharatanatyam dancers constitute a major part of Indian classical dancers' population. The traditional style of dancing technique should be understood and flexibility being one of the important parameter for a dancer's practice and performance, it should be assessed and physical techniques like yoga to improve the flexibility should be applied. Stretching techniques are very important and should be practiced before and after the dancing lesson. This may improve the flexibility or may help to at least retain the natural flexibility of the joints of the dancer. This will not only improve the performance of the dancers but also reduce the incidence of injuries in the performing artists.

CONCLUSION

Bharatanatyam dancers in our study had higher range of motion for flexion and abduction at hip joint compared to non-dancers which may be due to the regular practice of dance poses. There was no significant difference between the dancers and non-dancers in terms of hip external rotation and knee flexion even though the two commonest poses in bharatanatyam aramandi and muzhumandi involve hip abduction and external rotation and flexion at knee joint. There was also no significant difference in range of motion at ankle joint between bharatanatyam dancers and non-dancers. Additional training techniques like stretching before and after dance class and regular practice of yoga can be supplemented to improve the flexibility or retain the flexibility of joints.

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CONFLICT OF INTEREST

Authors declare that they have no conflict of Interest.

ABBREVIATIONS

ROM: Range Of Motion; **SEBT:** Star Excursion Balance Test; **ER:** External Rotation; **IR:** Internal Rotation; **DF:** Dorsiflexion; **PF:** Plantar Flexion.

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