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Assessment of muscle strength in female Bharatanatyam dancers

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Abstract

Bharatanatyam is an Indian classical dance form. Aramandi is the most basic position in bharatanatyam. There are various such positions to attain which dancers need optimal muscle strength and adequate motion at the required joints. The objective was to assess and compare the upper and lower limbs muscle strength in female bharatanatyam dancers and nondancers. 32 dancers and 33 nondancers participated in this study. Height, weight and BMI were measured. Lower limbs muscle strength was assessed by 6 metre hop test and wall sit test. Upper limbs muscle strength was tested by modified push ups test. Dancers took lesser time to hop 6 metres with both right and left leg ($P < 0.001$), sat for a longer time against wall ($P < 0.001$) compared to nondancers. Dancers performed more number of push ups than nondancers. ($P < 0.001$). This study showed that dancers had better lower and upper limbs muscle strength compared to nondancers.

Keywords: muscle strength, lower limb, upper limb, dance, bharatanatyam.

1. Introduction

Bharatanatyam is an Indian classical dance form. It involves NRITTHA which is rhythmic dance movements, NATYA which is dance in dramatic aspect and NRITHYA which is a combination of both. 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 Demiplie position of ballet dancers [1]. Here knees are flexed and there is abduction and external rotation at hip joints. [1] There are various such positions in bharatanatyam to attain which dancers need optimal muscle strength and adequate motion at the required joints. Dancers also require balance to maintain position and also while continuously changing postures and positions [1]. The population of dancers is very unique as they are not just athletes whose work intensity is no less than a football or a tennis 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. Various potential risk factors for dancers have been suggested ranging from physical overload to psychological distress, but there is a lack of any conclusive evidence on the risk factor. [3] The core stability and strength enhancement may possibly improve athletic performance and reduce incidence of injury [4]. The modified push – ups test assessed muscular strength and endurance [5]. Single-legged hop tests are performance based measures used to assess the combination of muscle strength, neuromuscular control. These tests commonly quantify knee performance in patients after anterior cruciate ligament (ACL) reconstruction [6]. Wall sit test is a simple test to measure the lower body muscular endurance especially quadriceps group [7]. There is a huge lacuna in the area of dance medicine in relation to the Indian classical dance [1]. The traditional practices of the dancers need to be carefully studied and juxtaposed with the modern system of physical training. This study has been taken up with the hypothesis that dancers have better muscle strength compared to nondancers. The objective of the study is, to assess upper and lower limb muscle strength and to compare them between dancers and nondancers.

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2. Materials and methods

2.1 Source of data

Bharatanatyam dancers were randomly selected from various bharatanatyam dance schools from Bengaluru and Non dancers were selected from general population. The approval and clearance from the institutional ethics committee was obtained before starting the study. The written informed consent was obtained from the subjects in the prescribed format in English.

2.2 Inclusion and Exclusion criteria

2.2.1 Inclusion criteria for dancers

- Female bharatanatyam dancers in the age group of 18-23 years.
- Dancers with formal training in bharatanatyam for minimum of 5 years and currently practicing for atleast for 6 hours a week.

2.2.2 Inclusion criteria for nondancers

- Normal healthy sedentary female subjects who are in the same age group and BMI matched.

2.2.3 Exclusion criteria

- Subjects with history of injury in past 1 year.
- Pregnant subjects.
- Subjects with formal training and currently practicing dance forms other than bharatanatyam or sports activities.

2.3 Study procedure

A written informed consent was taken from all the subjects. History regarding the general health status was taken. Questions regarding practice of dance and sports activities were administered to all the subjects. Height and Weight were measured and BMI was calculated. Based on the answers given by the subjects to the questions administered, those who fulfil inclusion criteria for dancers were included under dancers category and those who fulfil inclusion criteria for nondancers were included under non dancers category. As described in the standard protocol of the test, time was given

to familiarise with the test procedure for all the subjects.

2.3.1 Hop test

The hop test is a test to assess the muscle strength of the lower limb. Here the subject hops 6 meter distance with right limb and then with left limb. The time is noted each time. Three trials were done and time taken was expressed in seconds.

2.3.2 Wall sit test

The wall sit test is a test to assess the lower limb muscle strength. Here the subject leans with back against the wall and sits with hip at right angles. The hip and knee have to be in line and the ankle and knee have to be in line. The time is noted for how long the subject can maintain this position. Three trials were done and time was expressed in seconds.

2.3.3 Modified push ups test

The modified push up test is a test to assess the upper limb muscle strength. Here the subject performs the push up with knees on the ground (modified) and performs the repetitions lowering the elbow to 90° angle. The subject has to perform the repetitions in 1 minute and the number of repetitions was counted.

3. Results and Discussion

Bharatanatyam dancers took a significantly lesser time to hop 6 metres distance with right leg as well as left leg than nondancers. In dancers there was no significant difference between hop time of right and left legs indicating no asymmetry but the difference of hop time in nondancers was statistically significant. The dancers performed better in the wall sit test than nondancers and the difference between the groups was statistically significant. The dancers performed a significantly higher number of modified push ups in one minute compared to nondancers.

3.1 Tables and Figures

Table 1: Comparison of Anthropometric data between nondancers and dancers

Variables	Non-dancers group N=33			Dancers group N=32			Difference in mean	‘t’-value	P-value
	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	P<0.001*
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

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

	Dancer group		
	Range	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 hopping time (Seconds) between the two groups

Hop test (Seconds)	Non-dancers group N=33			Dancers group N=32			Difference in mean	‘t’-value	P-value
	Range	Mean±SD	SE	Range	Mean±SD	SE			
Right	6-3	4.3±0.58	0.10	5-3	3.97±0.59	0.11	0.33	2.28	P<0.00 *
Left	7-4	4.67±0.78	0.14	6-2	3.96±0.69	0.122	0.69	3.81	P<0.001*

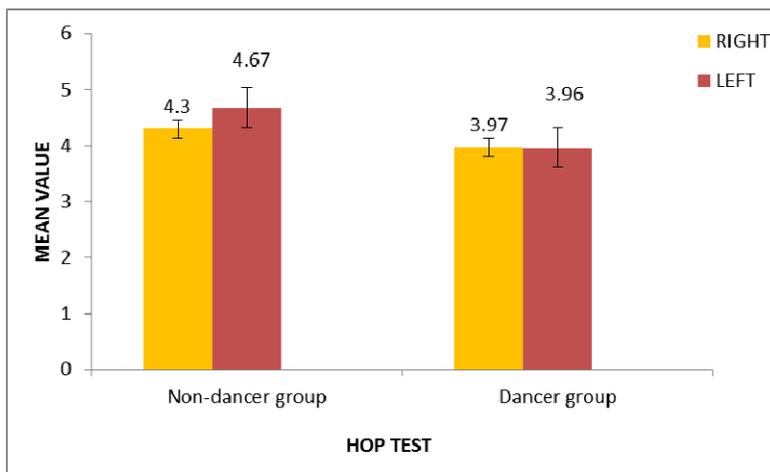


Fig 1: Mean hopping time (Seconds) in nondancers and dancers

Table 4: Comparison of right and left Limbs hopping time in dancers and nondancers

Hop test (Seconds)	Right			Left			Difference in mean	‘t’-value	P-value
	Range	Mean±SD	SE	Range	Mean±SD	SE			
Dancer	5-3	3.97±0.59	0.11	6-2	3.96±0.69	0.122	0.01	0	1
Non-Dancer	6-3	4.3±0.58	0.10	7-4	4.67±0.78	0.14	0.37	3.46	0.001*

Table 5: Comparison of wall sit test time (Seconds) between nondancers and dancers

Wall sit test (Seconds)	Non-dancer group N=33			Dancer group N=32			Difference in mean	‘t’-value	P-value
	Range	Mean±SD	SE	Range	Mean±SD	SE			
	52-3	21.69±12.82	2.23	100-14	54.71±19.32	3.41	33.02	8.14	P<0.001*

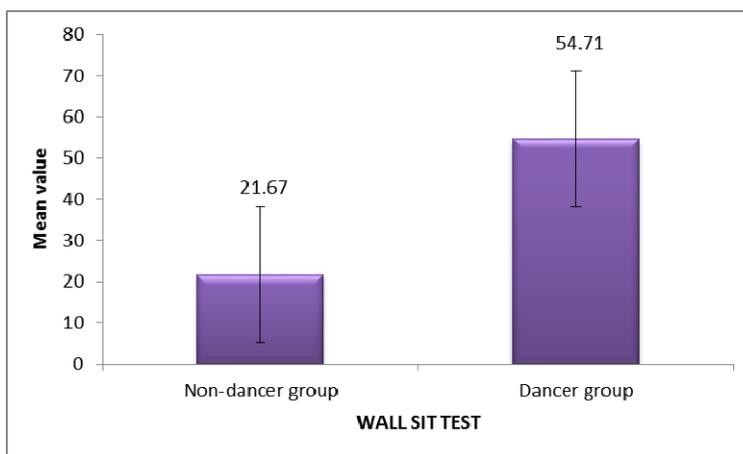


Fig 2: Mean scores of wall sit test (Seconds) in nondancers and dancers

Table 6: Comparison of number of push ups done by nondancers and dancers

Push ups (Number in 1 minute)	Non-dancer group N=33			Dancer group N=32			Difference in mean	‘t’-value	P-value
	Range	Mean±SD	SE	Range	Mean±SD	SE			
	59-23	38.61±6.94	1.21	69-37	49.12±7.52	1.33	10.51	5.86	P<0.001*

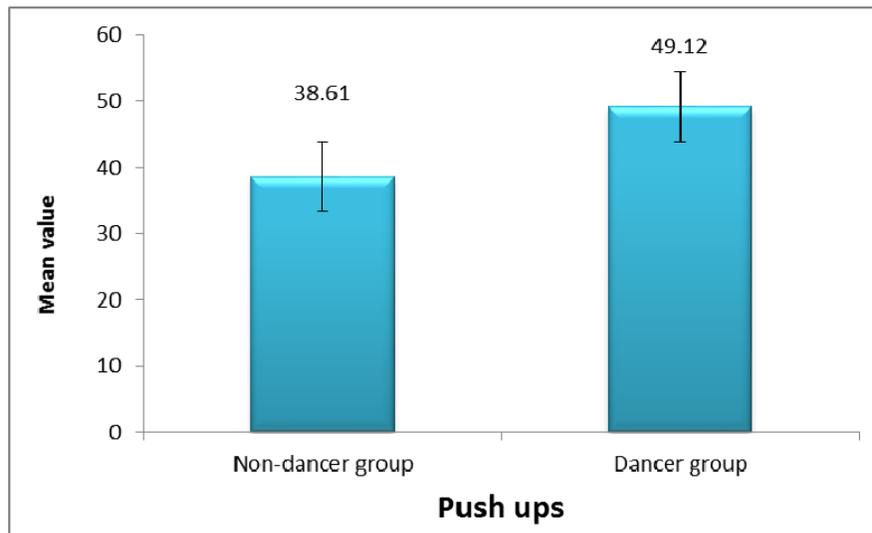


Fig 3: Mean number of modified push ups performed by nondancers and dancers

There are large numbers of professional, amateur and recreational dancers in the world. Dance is a good form of exercise and is considered as a sport. There are many classical dance forms in India. There are very few studies in these forms. This is one of the few studies that is assessing the kinetic parameters like muscle strength in bharatanatyam dancers. On an average bharatanatyam dancers spend around 30-40 minutes in aramandi position during 60 minutes of practice session.

Table 1 gives the anthropometric data of the subjects. The mean years of learning bharatanatyam dance and practice hours per week of dancers is given in Table 2.

Dancers are a unique combination of artist and athlete particularly susceptible to musculoskeletal injuries and pain. The health problems of dancers are important for many reasons. Firstly, most dancers begin training at a young age, there is potential for a great impact on their future health. Secondly, the physical and aesthetic demands in dance may lead to various health related issues especially relevant to dancers. For example, a variety of musculoskeletal disorders have been described in athletes and dancers due to lower limbs overload, which may have a significant impact on their health-related quality of life [8]. The imbalances in muscle strength may be developed from dance training by itself, for which additional strength training may be considered [9].

The dancers in our study had higher lower limb muscle strength compared to nondancers. They performed better in 6 metre hop test (Table 3, Figure 1) and in wall sit test (Table 5, Figure 2). There was no difference in the hopping time of right and left legs in dancers indicating no asymmetry (Table 4).

Muscular strength is a very important factor to improve the performance of a dancer and to reduce the risk of injuries. 6 Metre Hop test is a very good predictor of injury and has been used to monitor the rehabilitation process in injured athletes [6]. In a study by Bennell K L *et al* where in changes in hip muscle strength was assessed in 8-11 year old novice female ballet dancers and controls and were followed for 12 month period showed that strength increases occurred preferentially in ballet dancers in muscle groups specifically trained in ballet. Strength of hip external rotators, abductors, and adductors all increased significantly more in dancers than controls [10].

In a study by Gupta A *et al*, in which both ballet and

contemporary dancers participated. Here, dancers exhibited a greater right to left side strength difference than nondancers, and this greater asymmetry must be kept in mind when assessing a dancer's strength as it shows their preference of a single limb. This asymmetry may contribute to alterations in the kinetic chain and may be a risk factor for injury [11]. In our study, dancers did not exhibit asymmetry of leg strength as assessed by hop test unlike the above study. The increased muscle strength as well as no strength asymmetry may make our dancers less prone for injuries and may also contribute to improvement of their performance. The risk of falling increases with age and is contributed by poor balance and decreased leg strength. The wall sit test measures the isometric strength of thigh muscles. The leg strength improved significantly after a supervised 15 week exercise program [12].

The push-ups test measured muscular strength and endurance. The modified push up test performed for 1 minute requires upper body strength and power [5].

This study showed that dancers have better upper limb muscle strength compared to nondancers (Table 6, Figure 3).

The upper body Muscular endurance in modern dancers and controls was assessed by modified push ups test by Ambegaonkar JP *et al*, and the result of which was in contrast to our study. Despite dancers being more active/day, more times per week and having greater overall physical activity volumes than non-dancers, both groups had similar upper-body endurance which is in contrast to our study. This is probably due to the lack of physical activity beyond dance itself performed by the dancers. It is suggested that modern dancers should engage in strength and conditioning training programmes to enhance upper body endurance [13].

Strength is a very important physical quality that is essential for the dancer at all stages of their artistic career. It is important for dancer to have physical qualities that can be obtained through practice of yoga. The various standing poses such as Padahastasana, Padangushtasana, Trikonasana, Natarajasana, Virasana, Padottanasana, Garudasana are especially useful to develop strength in legs and thighs [14]. All the dancers are recommended to do regular yoga stretch (hatha yoga). The yoga, hatha yoga in particular is integral part of bharathnatyam. Over centuries this has been forgotten or ignored. It is note worthy that all stretching exercises necessary, for any athletic event or bharathnatyam is well

documented in hatha yoga ^[1]. The hand balancing poses such as Mayurasana, Titibasana, Vrichikasana, Dolasana, and Hamsasana develop strength in the shoulders, arms and wrists that is essential for holding the arms up in numerous nrittha sequences ^[14].

4. Conclusions

Bharatanatyam dancers had higher lower limb as well as upper limb muscle strength than nondancers which may make them less prone for injuries. Further research is required to check if this muscle strength is sufficient enough to improve performance and to prevent injuries or if dancers need additional strength training.

5. Limitations

Our study involved a small group of dancers and nondancers. Only females were included in this study. So it difficult to generalise the results of this study to whole dancers' population as it involves both male and female dancers.

6. Acknowledgements

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