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ORIGINAL ARTICLE

A STUDY TO COMPARE THE EFFECTIVENESS BETWEEN OTAGO EXERCISE AND MODIFIED OTAGO EXERCISE ON DYNAMIC BALANCE AMONG BHARATANATYAM DANCERS

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ABSTRACT

Background of the study: Bharatanatyam is an Indian Classical Dance which involves rhythmic dance movements. There are various postures in the dance form in which dancers need optimum muscle strength and adequate range of motion at required joints. Dancers need good body balance to maintain the postures. The main purpose of the study is to compare the effectiveness between Otago exercise and Modified Otago exercise on dynamic balance among Bharatanatyam Dancers. Methodology: This is an experimental study of Pre and Post comparative type. 20 Female Bharatanatyam Dancers were randomly selected for the study. The study setting was in Nritham; the School of Dance. Study duration is about 6 sessions in a week for 8 weeks. The inclusion criteria include only Female Bharatanatyam Dancers within the age group of 18–25 years. The recruited subjects were allocated into two groups, Group A received Otago exercise program and Group B received Modified Otago exercise program. The exercise program was given for 30 minutes per day for 8 weeks, before and at the end of the treatment session Star Excursion Balance test was assessed as outcome measure. Result: On comparing the mean values of Group A & Group B on Star Excursion Balance Test score for dynamic balance, it shows a significant increase in the post test mean values in both groups in all directions, but Group B was more effective than Group A at $P \le 0.001$. **Conclusion:** On comparing the effects between the groups showed Modified Otago Exercise Group B is more effective than Group A Otago Exercise.

Keywords: Bharatanatyam Dance; Otago Exercise Program; Modified Otago Exercise Program; Star Excursion Balance Test; Dynamic Balance.

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INTRODUCTION

Bharatanatyam is a South Indian classical dance style which is being performed by both men and women. It is pronounced as ba-tata-natiam. This dance style known as fifth veda and is usually regarded as India's oldest dance genre. Among all dance styles Bharatanatyam is the most highly developed dance form, evidence for this has been noted in 9th century, but till 1900's it was known as Sadir.

There are two ways to interpret the term Bharatanatyam. The first is because it is made up of terms that are related to BHAVA (expression), RAGA (melodic mode) TALA (rhythm) NATYAM (dance). The second reason for the name is that it is derived from a combination of two names they are the Sage Bharata Muni and the author of "Natya Shastra", so it is called Bharatanatyam¹.

The ancient Tamil epic Silappatikaram mentions the history of Bharatanatyam in the 2nd century CE, and in 6th to 9th centuries CE the Tamil Sculptures showed that this dance form is the well-refined performing art than other dance forms. The oldest classical dance tradition in India is Bharatanatyam. This dance tradition was popular in ancient Tamil Nadu, and numerous texts, including Natya Shastra, have codified it. Natya Shastra is just a codification of Tamil Nadu dance styles by an unknown author².

Natya Shastra includes NRITTHA (rhythmic dance movements), NATYA (dramatic dance), and NRITHYA, which is a mix of the two. ANGIKA is a kind of abhinaya that consists of physical or bodily motions³.

Dance is a form of literacy. It contains a vocabulary, employs syntax, and is semantically based, like conventional types of literacy that

are still favored in schools. Bharatanatyam dance classes resembles as a perfect illustration of a transmeadiated classroom, where students learn to change from one sign system to another under the guidance of the expert. In every class, students are continuously taught to do several sign systems that even include linguistic, dance, art, and music which supports the choreographies⁴.

Dance as a literacy, it is an activity in which individuals engage as doers and watchers, might flow over into a variety of topic areas, with a variety of outcomes: individual physical, artistic, and intellectual achievement; better individual and group problem-solving abilities; enhanced observation and writing skills; critical awareness of the body and dance as social constructs; social integration; historical and cultural understanding; and sensory, critical, intellectual, and creative involvement⁵.

According to Danseuse Alarmel Valli, "Dance offers a fantastic aerobic workout, increases blood circulation, tones muscles, and is beneficial for bone density because it is a contact exercise." Bharatanatyam, according to dancer and choreographer Anita Ratnam, provides both physical and mental advantages ⁶.

Dance is a kind of art that necessitates the use of intense human body motions. Dance demands a great deal of strength, range of motion, balance, neuromuscular coordination, and kinaesthetic awareness. The dancer's body is an instrument for expression, and for best performances, the same biomechanical and anatomical concepts must be used. According to recent research on male and female dancers, additional exercise training can enhance fitness indices and minimise the incidence of dance injuries⁷. Static postural control or balance is described as the capacity to maintain a steady base of support with minimum movement, whereas dynamic postural control or balance is defined as the ability to complete a task while keeping a stable stance. Sensory input from the somatosensory, visual, and vestibular systems, as well as motor responses that impact coordination, joint range of motion (ROM), and strength, all influence balance⁸.

To execute smooth, full movements, you must have good balance. Balance is considerably more vital to a dancer than it is to the typical individual who just wants to avoid falling over in the street. The dancer's balance is essential for excellent posture and movement. Good balance may make a dance appear effortless, allowing the rest of the body to focus on the work at hand instead of attempting not to wobble. We can complete motions more successfully when we have good balance, posture, and a strong core, and in dancing, every move you do must be completed or finished. Each movement, from head to feet to fingers, should be fully extended and stretched. This improves the flow, form, and line of a routine. Consequently, the entire performance will look to have more ease, polish, and improved technical components. A routine lacks of balance and extension appear awkward, unstable and sloppy⁹.

Aim of the study: The aim of the study was to compare the effectiveness between Otago exercise and Modified Otago exercise on dynamic balance among Bharatanatyam Dancers.

Need of the study: Bharatanatyam is a classical Indian dance form that traces its roots to the 2nd century and is still one of the most popular and widely practiced dance forms in India. It

uses a lot of movements in different stances with superimposed limb movements. The dancer needs their balance to be secure in good posture and movement. Good balance can make a dance look effortless and allow the rest of the body to pay attention to the job of carrying out the routine rather than trying not to wobble. This study was to dynamic balance examine in female Bharatanatyam Dancers and to improve imbalance using exercise program.

METHODOLOGY

This is an experimental study of Pre and Post comparative type. 20 Female Bharatanatyam Dancers were randomly selected. The study setting was in Nritham; the School of Dance. Study duration is about 6 sessions in a week for 8 weeks. The inclusion criteria include only Female Bharatanatyam Dancers within the age group of 18–25 years. The recruited subjects were allocated into two groups, Group A received Otago exercise program and Group B received Modified Otago exercise program. The exercise program was given for 30 minutes per day for 8 weeks, before and at the end of the treatment session Star Excursion Balance test was assessed as outcome measure.

Exclusion criteria were Subjects with the history of injury in past 1 year, Recent Fractures, Ligament injuries, Pregnant subjects, Dizziness, neurological disorders that impaired their ability to complete the testing protocol, Male subjects, Subjects unwilling to participate in the program.

Materials used for this study: White athletic tape, Chalk (to draw the testing grid of 8 lines, each 120 cm in length extending from a common point at 45° angle increment), Measuring tape (to measure the leg length and

reach distance), Recording sheet, Consent form, Other stationary materials.

Measurement tool used in this study: Star Excursion Balance Test (SEBT).

Outcome measures of the study: Dynamic Balance, Postural Stability, reach distance

Procedure: After obtaining the ethical clearance from the Institutional Review Board, Faculty Of Physiotherapy, DR. MGR Educational and Research Institute, CHENNAI. 20 subjects from Nritham - The School of Dance were recruited based on the inclusion and exclusion criteria. An informed consent form was collected from the subjects after detailed explanation about the procedure. Following this, a standardised history which consisted of demographic information such as age, gender and occupation were collected.

Questions regarding the general health status and practice of dance activities were taken. Height and Weight were measured. Based on the answers given by the subjects to the questions administered, those who fulfil inclusion criteria for dancers were included in the program. Duration of symptom was noted and initial evaluation of balance is done using Star Excursion Balance Test (SEBT). As the standard protocol of the Star Excursion balance test, time was given to familiarise with the test procedure for all the subjects. After this initial evaluation, they were allocated into Group A and Group B.

Group A and B received 10 subjects Otago Exercise program and Modified Otago Exercise program respectively.

Star excursion balance test:

Limb length measurement: The star excursion balance test (SEBT) is a test to assess the

dynamic balance. Lower limb length was measured in order to normalize SEBT reach distance. Subject was asked to maintain supine lying on a plinth, then was asked to perform a bridge by lifting his hip from the plinth. Therapist passively straightened the legs. Using a measuring tape, the lower limb length was recorded in centimeters from the inferior aspect of anterior superior iliac spine to the most distal portion of the medial malleolus.

The subject was asked to maintain a stable single leg stance with stance leg or the test leg and reach for the maximum distance with the other leg which is the reach leg in 8 directions. The same is repeated for the other leg also. The subject was asked to reach without using the leg for support. In order to successfully complete the attempt, the subject was asked to maintain reach for 1 second and come back to starting position that is both feet together without touching each other. Again from the starting position the subject was asked to attempt for reach in the next direction.

Otago Exercise Program - Group A

The 8 directions are anterior, antero lateral, lateral, postero lateral, posterior, postero medial, medial and antero medial. The pre test data's of both the groups on SEBT test were collected and calculated. Both the Groups were instructed to perform the respective exercises for the period of 8 weeks for 6 sessions a week (one hour / day).

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Balance Exercises	Repetitions
1 - Knee Bends	2-3 repetitions
2 - Toe raises	2-3 repetitions
3 - Calf raises	2-3 repetitions
4 - Single leg stand	10 seconds
5 - Heel toe walking	10 steps

Table 1; Exercise Program

OTAGO Exercise Program (First 4 weeks) - Group A

- Knee Bends: Subject was instructed to stand up tall with both hands lifted up in a half way
 Place feet and shoulder width apart. When subject feels their heel start to lift, straighten up, Repeat 2-3 times.
- Toe Raises: Subject was instructed to stand up tall hold on and look ahead the feet and shoulder width apart and come back onto the heels, raising the front foot off the floor. Lower the feet to the ground and Repeat this 2-3 times.

3. Toe Raises:

Subject was instructed to stand up tall on their toes hold on and look ahead. The feet and shoulder apart and come up on their toes. Lower the heels to ground. Repeat this 2-3 times.

4. Single Leg Stand:

Subject was instructed to stand up tall hold on and look ahead stand on one leg try to hold their position 10 seconds. Take rest and stand on other leg.

5. Heel Toe Walking:

Subject was instructed to stand up tall hold on and look ahead place one foot directly in front of the other, so they form a straight line. Place the foot behind directly in front, Repeat for 10 more steps.

Balance Exercises	Repetitions
1- Standing on one foot	Up to 1 minute
2- Walking heel to toe	20-40 repetitions forward & backward
3- Heel walking	20-40 repetitions forward & backward

 Table 2. Balance
 Exercise Program

Strengthening Exercises	Repetitions
1- Side-kicks	20-40 repetitions with red Theraband
2- Wall-squats	20-40 repetitions

Table 3. Strengthening Exercise Program

Modified Otago Exercise Program - Group B

1.Walking Heel to Toe:

Subject was asked to walk with heel of one foot touching the toes of other foot. Repeated 20-40 times in forward and backward directions.(Hold for support progress to no hold).

I. Balance exercises:

1. Standing on one foot:

Subject was asked to stand on one foot holding on to a support if needed; Progress to stand on one foot for one minute without holding. Repeated 2 times per leg for 4 minutes. (As opposed to 30 seconds used in original Otago exercise program)

2. Walking Heel to Toe:

Subject was asked to walk with heel of one foot touching the toes of other foot. Repeated 20-40 times in forward and backward directions.(Hold for support progress to no hold).

3. Heel Walking:

Subjects was asked to walk on their heels for 20-40 repetitions forward and backward.(in original Otago exercise program Heel walking is in forward direction only).

II. Strengthening exercises:

1. Side - Kicks:

Subjects, while standing, were directed to raise their leg out straight to the side while holding on a stable surface without leaning, 20 repetitions per leg. One to two minutes of rest was given between exercising each leg, which differs from the original Otago that uses ankle cuff weights.

2.Wall Squats:

This exercise was included as an additional exercise to the original Otago exercise program to fit the functional level of the subject. The subjects were requested to slide down on a wall to a sitting position with their ankles placed under their knees in a perpendicular manner to avoid knee injury.

Once the subject reached the sitting position with their knees and hips at 90 degrees of flexion, they returned to the erect standing position and performed the same exercise in a continuous fashion for 20-40 repetitions.

After the completion of 8 weeks, post test data's of SEBT test from both the groups were collected. These post test data's were compared with their respective pre test data's of both the groups.

Data Analysis

The collected data were tabulated and analyzed using both descriptive and inferential statistics. All the parameters were assessed using statistical package for social science (SPSS) version 24. Paired t-test was adopted to find the statistical difference within the groups & Independent t-test (Student t-Test) was adopted to find statistical difference between the groups.

	GROU	JP - A	GROU	JP - B			
#SEBT					T- TEST		Sig.
DIRECTIONS	MEAN	S.D	MEAN	S.D		ai	
Anterior	53.39	4.46	54.75	4.03	715	18	.484*
Antero Lateral	50.04	4.73	48.27	4.75	.836	18	.414*
Lateral	39.39	3.54	39.38	5.52	.003	18	.998*
Postero lateral	37.93	3.54	38.70	2.47	561	18	.581*
Posterior	43.74	4.18	43.52	4.12	.118	18	.907*
PosteroMedial	63.06	1.91	63.93	3.35	715	18	.484
Medial	62.28	.871	63.23	3.01	957	18	.351*
Antero Medial	41.67	3.81	41.66	3.10	.007	18	.994*

Table-1. Comparison of SEBT score Between Group – A and Group - B in Pre test, (*- p > 0.05)

The above table reveals the Mean, Standard Deviation (S.D), t-test, degree of freedom(df) and p-value between (Group A) & (Group B) in

pre test. This table shows that there is no significant difference in pre test values between Group A & Group B (*P > 0.05).

	GROU	JP - A	GROU	IP - B		df	Sig.
#SEBT DIRECTIONS	MEAN	S.D	MEAN	S.D	T-Test		
Anterior	71.62	.914	82.09	1.21	-21.75	18	.000***
Antero Lateral	64.43	1.22	74.82	.904	-21.51	18	.000***
Lateral	50.74	1.20	61.74	2.98	-10.80	18	.000***
Postero lateral	48.66	1.16	62.37	3.03	-13.31	18	.000***
Posterior	54.25	1.10	70.67	3.27	-15.08	18	.000***
Postero Medial	66.62	6.14	84.41	2.77	-8.34	18	.000***
Medial	68.17	4.49	78.53	4.91	-4.92	18	.000***
Antero Medial	62.27	.784	81.47	3.48	-16.98	18	.000***

Table- 2. Comparison of SEBT Score between Group – A and Group - B in Post Test, (***- P < 0.001).

The above table reveals the Mean, Standard eviation (S.D), t-test, degree of freedom(df) and p-value between (Group A) & (Group B) in post

test. This table shows that there is a significant difference in post test values between Group A & Group B (*P < 0.001).

	PRE	TEST	POST TEST			
#SEBT					T Tost	Sig.
DIRECTIONS	MEAN	S.D	MEAN	S.D	I- Test	
Anterior	53.39	4.46	71.62	.914	-12.50	.000***
Antero Lateral	50.04	4.73	64.43	1.22	-8.55	.000***
Lateral	39.39	3.54	50.74	1.20	-10.50	.000***
Postero lateral	37.93	3.54	48.66	1.16	-10.29	.000***
Posterior	43.74	4.18	54.25	1.10	-9.04	.000***
Postero Medial	63.06	1.91	66.62	6.14	-1.84	.000***
Medial	62.28	.871	68.17	4.49	-3.96	.000***
Antero Medial	41.67	3.81	62.27	.784	-16.69	.000***

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The above table reveals the Mean, Standard Deviation (S.D), t-test and p-value between pre test and post test within Group A. This table

shows that there is a significant difference in pre and post test values within Group A (*P < 0.001).

	PRE T	EST	POST TEST			
#SEBT					T Test	Sig.
DIRECTIONS	MEAN	S.D	MEAN	S.D	I- Test	
Anterior	54.75	4.03	82.09	1.21	-19.16	.000***
Antero Lateral	48.27	4.75	74.82	.904	-18.18	.000***
Lateral	39.38	5.52	61.74	2.98	-12.39	.000***
Postero lateral	38.70	2.47	62.37	3.03	-20.85	.000***
Posterior	43.52	4.12	70.67	3.27	-21.91	.000***
Postero Medial	63.93	3.35	84.41	2.77	-17.82	.000***
Medial	63.23	3.01	78.53	4.91	-12.85	.000***
Antero Medial	41.66	3.10	81.47	3.48	-25.48	.000***

 Table - 4. Comparison of SEBT Score between Pre Test and Post Test within Group B, (*P < 0.001).</th>

The above table reveals the Mean, Standard Deviation (S.D), t-test and p-value between pre test and post test within Group B.

This table shows that there is a significant difference in pre and post test values within Group B (*P < 0.001).

RESULTS

On comparing the mean values of Group A & Group B on Star Excursion Balance Test score for dynamic balance, it shows a significant increase in the post test mean values in both groups in all directions, but (Group B - Modified Otago Exercises) which has the higher mean value in all directions are more effective than (Group A -Otago Exercises) at $P \le 0.001$. Hence the null hypothesis is rejected.

On comparing Pre test and Post test within Group A & Group B SEBT score in all directions shows highly significant difference in mean values at $P \le 0.001$

DISCUSSION

The purpose of the study was to find the effectiveness of OTAGO exercise program and Modified OTAGO exercise program in Bharatanatyam dancers with dynamic imbalance. Group B showed improvement in dynamic balance due to application of Modified OTAGO exercise program, Group A also showed mild changes due to application of OTAGO exercise program.

Main intend of the study is to evaluate a modified version of OTAGO exercise program that was designed specifically target and improve balance and strength and prevents fall during any dance performance. It was evident from the mean value that Group B showed improvement in SEBT test because of the exercise program.

In the present study, dancers had lower dynamic balance and may make them more prone for injuries. Poor performance on the SEBT may be related to an increased risk for sustaining a noncontact lower extremity injury. Following an 8 weeks training program that focused on stability, dynamic balance and lower extremity strength in female Bharathanatyam dancers showed significant improvement in SEBT composite score on both groups. Improvement in dynamic balance seen in both groups can be attributed to the effect of exercise program prescribed in the study. The prescribed six session's weekly dosage of exercise might have enhanced subject's strength and dynamic balance.

In this study strengthening hip and ankle muscles was part of the exercise protocol that is essential to pelvic stability and it is evident when practicing on SEBT. One of the exercises mentioned in this study which is one minute single leg standing exercise it was used as a form of balance training. In modified version of OEP the volume and intensity of the exercise is increased to better fit the muscle performance and posture systems of subjects. Therefore, repetitive training using the augmented relative OTAGO exercise for fall prevention leads to decrease in fear of fall during dance performance in bharathanatyam dancers.

Lower limb muscle weakness is considered a fall predictor, thus the original OEP focuses on improving lower limb strength that usually reduces with aging. In the exercise group, results of the repeated measures analysis of variance (ANOVA) showed significant improvements in the reach distance in all the directions (p<0.001). In contrast, the non-exercise group had significant difference only in the left postero lateral direction (p = 0.009). Participants in the exercise group achieved significantly greater reach distance ¹⁰.

More than a decade of research findings has established a comprehensive portfolio of validity for the SEBT, and it should be considered a highly representative, noninstrumented dynamic balance test for physically active individuals. The SEBT has been shown to be a reliable measure and has validity as a dynamic test to predict risk of lower extremity injury, to identify dynamic balance deficits in patients with a variety of lower extremity conditions, and to be responsive to training programs in both healthy people and people with injuries to the lower extremity ¹¹.

The reliability of the SEBT components ranged from 0.82 to 0.87 (ICC3,1) and was 0.99 for the measurement of limb length. Logistic regression models indicated that players with an anterior right/left reach distance difference greater than 4 cm were 2.5 times more likely to sustain a lower extremity injury (P<.05). Girls with a composite reach distance less than 94.0% of their limb length were 6.5 times more likely to have a lower extremity injury ¹².

Statistical analysis reveals that there are significant changes in all baseline values. Outcome measures were collected from both prior to the training (pre test score) and after the 8 weeks of training (post test score). From the post test data it was found that there was an improvement in Group B subjects as there was increase in body balance. Result of present study showed that Group B which was treated with modified OTAGO exercise program had improvement in reducing falls. Group A which was treated with Modified OEP had showed a significant improvement (p<0.001) in dynamic balance and strength ¹³.

Comparing Stability Scores between Healthy and Injured Skateboarders at Levels 12 and 8 The means and standard deviations of stability scores for healthy and injured skateboarding players at levels 12 and 8 are listed in Table 6. There was no significant difference in stability scores between healthy and injured skateboarding players ¹⁴.

The data were analyzed and compared for each of the individual tests between the dancers and non-dancers. The values for the unilateral stance show the comparison between 'sway velocities' (m/sec) for the dancers and nondancers. The results for each of the tests are as follows3.1. Left unilateral stance with eyes open, Movement velocity was measured as the velocity achieved by the respective groups to reach their end point (m/sec). 3.3. Maximum excursion Is expressed as a percentage % of the total area to be covered from the starting to end point. 3.4. Directional control Expressed as a percentage of stability maintained during the movement towards the target, compared and recorded for both the groups respectively ¹⁶⁻¹⁷.

Improvements in balance, functional ability, and leg functioning in frail elderly people have been noted by giving standing, static balance exercises conducted independently without safety supervision. The frail elderly are basically individuals above 65 years and depending on their level of activities, often under institutional care. There is also a weak evidence that some types of exercise (gait, balance, co-ordination and functional tasks; strengthening exercise; 3D exercise and multiple exercise types) are moderately effective. It could be because physiological changes which are inevitable with aging also may be because of different in lifestyle and the energy demands pose in later life¹⁸⁻¹⁹.

Following the 8 weeks of dynamic balance training significantly improved in this study sample. This study illustrates how relatively healthy and active subjects can benefit from performing comprehensive strengthening and balance exercises that challenges muscle performance and postural systems.

Ethical clearance: Ethical clearance was obtained from the Institutional ethical committee, Dr. MGR. Educational and Research Institute, Chennai with reference No. A-08/PHYSIO/IRB/2020-2021 approval letter dated 08/03/2021.

Conflicts of Interest: There is no conflict of interest to conduct this study.

Fund for the study: This is self-funded study.

CONCLUSION

On comparing the pre-test mean values of SEBT score between Group A and Group B showed minimal significance. On comparing the posttest mean values of SEBT between Group A and Group B showed significant difference. Hence, the post-test mean values of SEBT showed that Group B (Modified Otago Exercise) is more effective that Group A (Otago Exercise).

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