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CORRELATION BETWEEN LUMBAR LORDOSIS AND DYNAMIC BALANCE IN FEMALE BHARATNATYAM DANCERS USING PELVIC INCLINOMETER AND STAR EXCURSION TEST

A correlational Study

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Abstract:.Bharatnatyam is an ancient dance form practiced in India till today.The dancers are trained in such a way that they have to maintain certain postures for longer period of time eg "Arimandi"in this posture the person has to do half squat and in order to keep the upper body upright the individual has to go in lumbar lordosis, over the time the posture of bharatnatyam dancers has seen to have increased lumbar lordosis.This increased lumbar lordosis in normal individuals may lead to hampering of the dynamic balance .Hence this study was done to find out wheatherprofessional bharatnatyam dancers having increased lumbar lordosis have impaired dynamic balance too.So this study aims at finding correlation between lumbar lordosis and dynamic balance .

Method –A correlational study was done in which 80 professional women bharatnatyam dancers were taken with age group of 18-30 years,having 3 or more years of experience in and around PCMC area Pune using purposive sampling as per inclusion criteria. Dancers with recent lower limb injuries were excluded. Concent was taken from the participants.Frst the lumbar lordosis was measured using pelvic inclinometer and later the star excursion test was performed to find out the dynamic balance of the participants.Later on data was collected , statistical analysis was done and results were tabulated.

Conclusion -This study concludes thattheir is no correlation between the dynamic balance and pelvic inclination (increased)) in female bharatnatyam dancers.

Index Terms - Dynamic Balance, Arimandi, Lumbar lordosis.

I. INTRODUCTION

Bharatnatyam is an Indian classical dance form that originated in Tamil Nadu.[1] Traditionally this has been a solo dance that was performed by women in the Temples [(2,3)]and it also expressed South Indian religious themes, spirituals ideas, particularly of Shaivism, but also of Vaishnavism and Shaktism. [(1,4,5)]. Gaining proficiency in Bharatanatyam dance form necessitates maintenance of different postures for prolonged duration. These repetitive movements place tremendous physical demands on the body at young age and may alter the postural profile of the dancer. [2] Majority of the adavus are performed in the Ardhamandali position- the basic stance of this art form in which the torso is held erect with the legs bend at the knees and feet are flexed sideways,horizontally in a line with a distance of one span between the heels. This position requires the dancer to compress one's height to at least 3/4th of their original height.[6]

The Araimandi is the basic of Bharatnatyam dance; 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. Ankle bells (ghungaroos) further adds to the stress experienced by the foot. Daily use of these ankle bells may overload the connective tissues of legs and can lead to overextension, tendon strain and other connective tissue injuries during the performance.[6]

Practice of a faulty posture for a long time in one's dancing career could also result in a permanent structural change. Hence this study will focus on studying the lumbar spine curvature and pelvic inclination in standing and correlate both. Pelvic tilt is defined as the angle between the horizontal plane and a line passing through the midpoint of the posterior superior iliac spines and the midpoint of the ASIS. Lumbar lordosis is the curve assumed by the lumbar spine, where the lumbar spine forms an anterior convexity. [1]

FIG 1: Arimandi posture in Bharatnatyam

The degree of lumbar lordosis is variable among individuals and is the result of many factors, including the fact that the L5 vertebra is wedge-shaped, with the anterior aspect of the vertebral body being approximately 3mm higher than the posterior aspect. The intervertebral discs in the lumbar area are also wedge-shaped, especially at the L4 –L5 and L5 –S1 segments.[1]The intervertebral disc at the L5 –S1 interspace has been measured to be 6-7mm higher anterior than posteriorly. The vertebrae above L5 are less wedge-shape of the L5 –S1 vertebral levels, each vertebra above this level lies slightly behind the vertebra above.[6]Wrong adaptation of this posture could impose an excessive stress on the spine, especially the lumbar spine,and result in pain, disability among the dancers and also result in increased absenteeism from dance training sessions. Practice of a faulty posture for a long time in one’s dancing career could also result in a permanent structural change. [6]

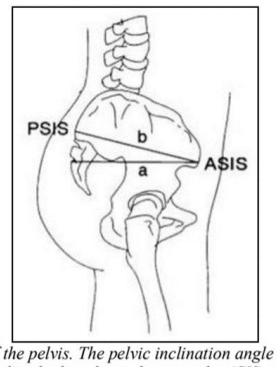

FIG:2 *Schematic diagram of the pelvis. The pelvic inclination angle is defined as the angle between the horizontal and a line drawn between the ASIS and the PSIS.*

Pelvic inclinometer is clinically used to measure pelvic inclination angles in a non-invasive, quick and user friendly and harmless method. Hand held inclinometer ICC value of 0.9 and Cronbach's alpha value of 0.88of rt. And lt. innominates respectively throughout, showing strong intertester reliability. Intra- tester reliability also demonstrated strong congruity with an ICC value ranging from 0.921-0.88 for rt. And lt. innominate respectively, showing strong intratester reliability.[7]

Dynamic balance involves stabilizing the body when the support surface is moving or when the body is moving on a stable surface11.Dynamic balance is required for many day to day activities as well as in complex activities like sports. Dynamic balance is achieved by integrated action of the central and peripheral components of the nervous system.Peripheral components of nervous system consist of somatosensory, visual, and vestibular systems which provide perception of body orientation in space.Foot form a part of lower limb kinetic control chain which provide part of somatosensory input to maintain balance.[1]

Hence this study will focus on finding correlation between increased lumbar losrdosi and dynamic balance in Bharatnatyam dancers.Pelvic inclinometer will be used to assess the degree of lumbar lordosis and for checking the dynamic balance star excursion test will be used.

II. METHODOLOGY

This study is conducted on 80 subjects who have been practicing bharatnatyam since 3 years or more, age 18-25 years old in and around pimpri –chinchwad area Pune . Ethical committee clearance was obtained and permission was taken from the bharatnatyyam dance class. Written consent was taken from the subjects who fulfil the inclusion criteria and exclusion criteria. The subjects were informed about the test and the measurement to be taken . Pelvic inclination and star excursion balance test was performed. Correlation coeffitsion was calculated between pelvic inclination and mean of star excursion test, statistical analysis and interpretation was done.

II.A INCLUSION CRITERIA

- Age- 18– 30 years [6]
- Female bharatnatyam dancers
- Year of experience- 3 years and above

II.B EXCLUSION CRITERIA

- Recent lower limb injury
- Recent surgery

II.C OUTCOME MEASURES

PELVIC INCLINOMETER MEASUREMENT

- Theangle of pelvic inclination in the sagittal plane was defined as the angle with the horizontal plane and a line passing through the posterior superior iliac spine (PSIS) and the anterior superior iliac spine (ASIS).
- The degree of pelvic tilt is measured as follows:-

1. The location of the ASIS and the PSIS are determined by examination and palpation and marked with a felt tip pen.
2. One end of the tip of the caliper of the pelvic inclinometer is placed over the ASIS and the second tip over the PSIS of the same ilia.

3. Then we have to bring the closed end of the calipers to a position such that pendulum hangs between the protractor and its back plate

Fig 3

STAR EXCURSION BALANCE TEST

- Is used to assess dynamic balance control in young adults. For SEBT, star shaped grid will prepared on the floor using sticking tapes. The grid consists of eight lines of 1m extending out at 45 degrees from each other.
- Subjects will be allowed to practice reaching in each of the eight directions three times with each leg before the actual trial. Then 5 minutes rest pause will be given to avoid learning effect.
- Subjects will be asked to stand in the middle of the grid with right foot first. Subjects begin with anterior direction and progress to counter clockwise, Similarly, test for Left leg done.
- Three test trials will be given each leg and distance is noted. Normalised SEBT distances will be found out by dividing each of the distance with limb length of respective leg
- Reliability of SEBT inter-rater (0.86-0.96) and intra –rater (0.84-0.93)[10]

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Fig 4

- Scoring System :- With the test complete and all performances measured and recorded, the test administrator can then calculate the athlete's SEBT performance scores using the following simple equations:
- Average distance in each direction (cm) = Reach 1 + Reach 2 + Reach 3 / 3
- Relative (normalised) distance in each direction (%) = Average distance in each direction / leg length *100

III. STATISTICAL ANALYSIS

Data was collected and analyzed by Pearson's correlation coefficient statistical test.

For statistical analysis, MedCalc software is used.

IV. RESULTS

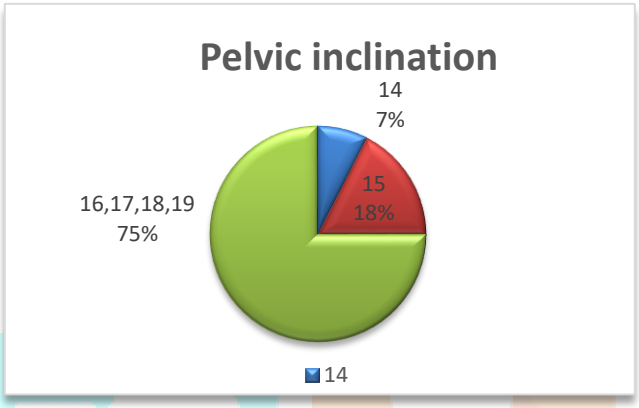


Chart -1

Pelvic inclination (in degree)	No. of participants
14	6
15	14
16,17,18,19	60

Table-1

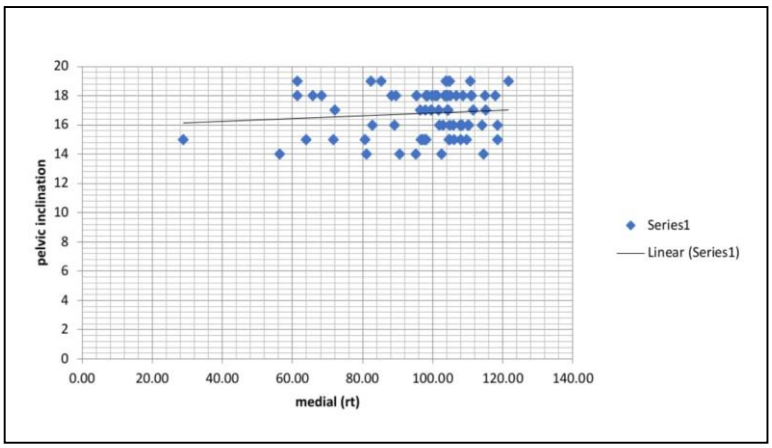
The normal value for pelvic tiltis 13 and in females is 15 [7].The above pie chart shows that only 7% population had reduced pelvic inclination than normal. 18% of the population had normal pelvic inclination, and 75% population had increased pelvic inclination (lordosis).

The correlation between individual three directions and pelvic inclination was calculated, following were the results:

I. RIGHT LEG

1) Table – 2

REARSON'S r	0.010
P	0.815

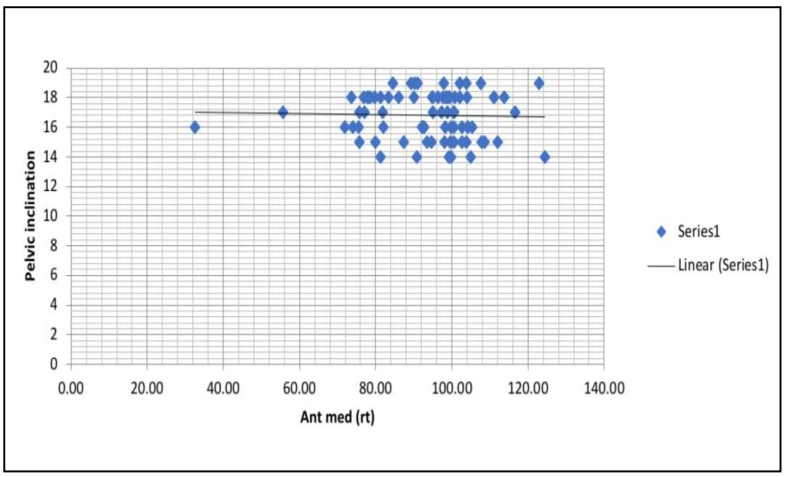


INTERPRETATION CHART-2

Table 2 –The above table-2 and the chart-2 shows that there is no correlation between the medial direction reach of the right leg and pelvic inclination.

2) Table -3

Pearsons's r	0.0206
P	0.966



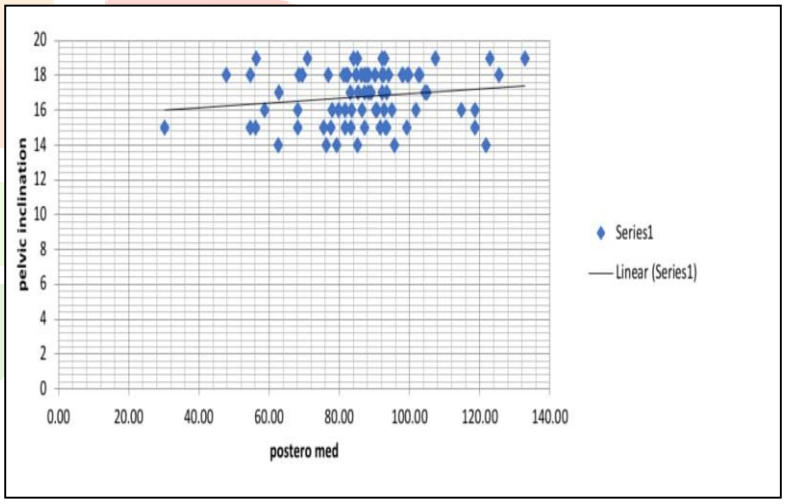
INTERPRETATION

Table 3 –The above table-3 and the chart-3 shows that there is no correlation between antero-medial direction of the right leg and pelvic inclination.

CHART-3

3) Table -4

Pearson's r	0.015
P value	0.165



INTERPRETATION

Table 4 –The above table-4 and chart-4shows that there is no correlation between post-medial direction reach and pelvic inclination.

CHART-4

II. **LEFT LEG**

1) Table – 5

Pearson's r	**0.244**
P	0.028
Pearson's r	**0.217**

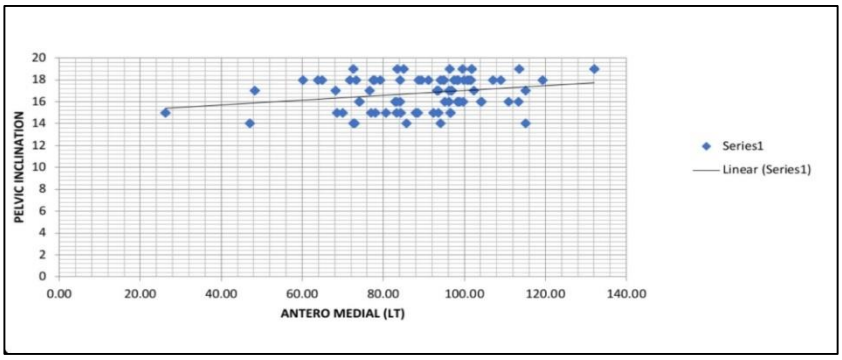


CHART-5

Interpretation

Table-5The above table-5 and the graph -5shows no significant correlation between anteromedial direction reach and pelvic inclination.

2) Table- 6

Pearsons's r	**0.015**
p	0.91

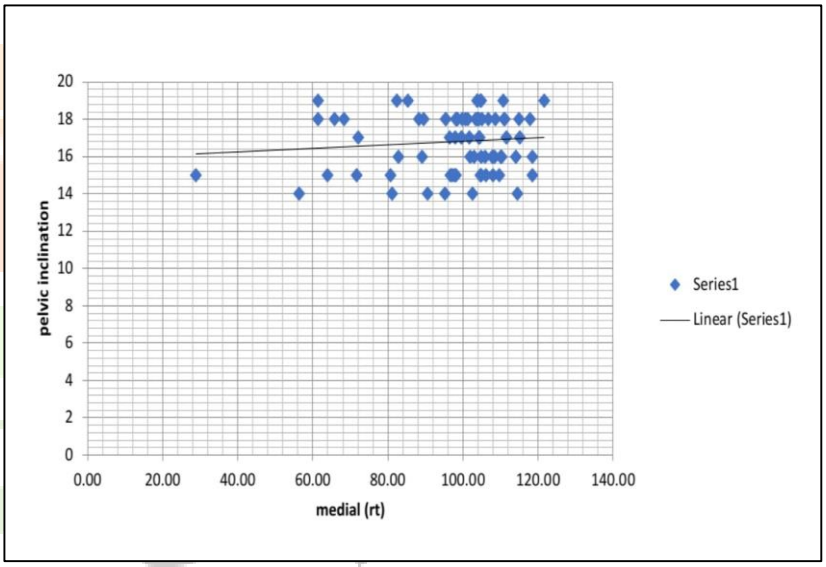


CHART-6

Interpretation

Table 6- The above table-6 and graph-6 shows that there is no significant correlation between medial direction reach and pelvic inclination.

3) Table-7

p	0.953

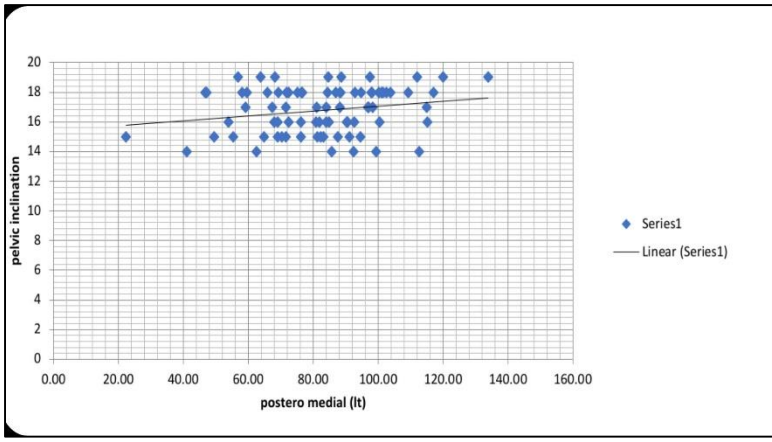


CHART-7

Interpretation

Table 7- The above table-7 and the graph-7 shows that there is no significant correlation between postero-medial direction reach (lt) and pelvic inclination\

III. Average correlation

Pearson's r	**0.247**
p	0.027

Table 8

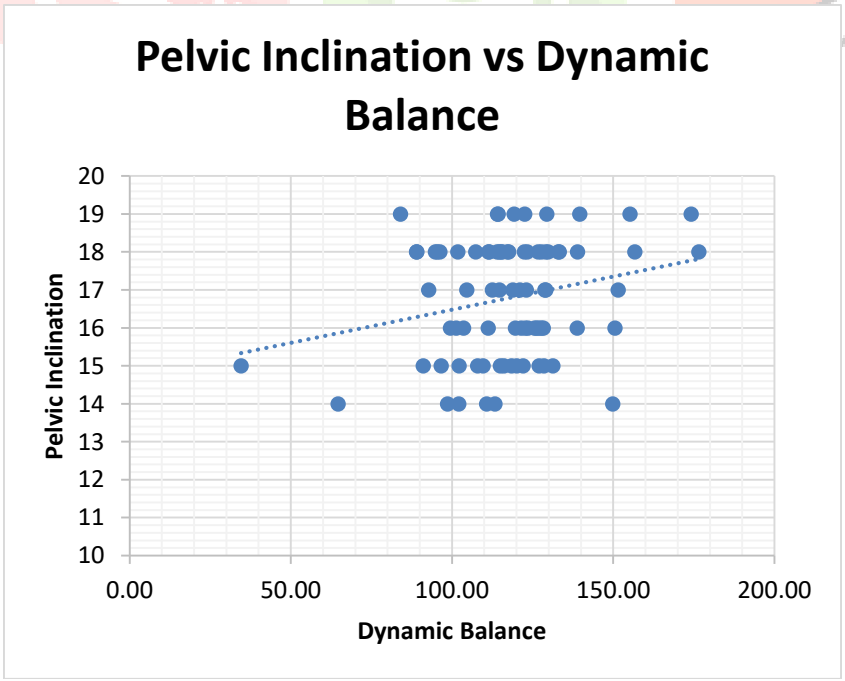


CHART-8

Karl Pearson's Correlation coefficient was computed between Dynamic Balance and Pelvic Inclination. The above table- 8shows r value = 0.247, hence it can be concluded that there is a very low degree of positive correlation observed between Dynamic Balance and Pelvic Inclination.

Interpretation

Table 8- the above table-8 and the graph-8 shows that there is no significant correlation between total dynamic balance and pelvic inclination.

III. DISCUSSION

This study aimed to find the correlation between dynamic balance and lumbar lordosis in female Bharatanatyam dancers. In this study, we have observed that there is increased pelvic inclination anteriorly .(and pelvic tilt)this is because posture is one of the factors affecting the dynamic balance, but it is not the only factor affecting it due To the balance training in Bharatanatyam, the dancers have excellent dynamic balance, despite of increased lumbar lordosis.

The total number of study participants were 80 females who had years of experience and more and were willing to participate in the study, between the age group of 18-30 years. They were asked to perform a star excursion test, and later their degree of pelvic inclination was measured. Later, on statistical analysis we found that Pearson's correlation coefficient for anteromedialrighr was r=0.206, anteromedial left was r=0.11, for medial right r=0.103, medial left r=0.0153, for posteromedial right r=0.0156, posteromedial left r=0.214 which suggested that their was no correlation between anteromedial, medial and posteromedial directions of star excursion test (left leg and right leg) with lumbar lordosis or pelvic inclination.

Also the Pearson correlation coefficient for total dynamic balance and pelvic inclination was r= 0.247 which also suggest that there is no correlation between both. The reason behind it may be that the dynamic balance is dependent on many factors like posture, vestibular system , lower limb strength , etc. It has been speculated that during rhythmic stamping of the feet (Tatkara) a dancer receives constant proprioceptive feedback from proprioceptors located in the plantar surface of the foot that relay information about the dance surface to higher centers, thereby activating the ankle and hip activity during body sway under static and dynamic conditions and effectively improving postural stability. [12,13,14.] As Indian dance forms involve constant proprioceptive input received by the dancer while performing on varied surfaces, this transference of information likely resulted in the dancers' better balance performance on clinical balance assessment.[7]

In a study conducted by Juhi K. Bharnuke, PT, Rajani P. Mullerpatan, PT, PhD, and Claire Hiller, PhD they aimed to compare the standing balance of 36 active female dancers (18 to 25 years of age) who had performed Indian classical dance for a minimum of 10 years with 36 healthy age-matched women not involved in regular physical activity. Balance was evaluated in static and dynamic conditions of single and dual-limb stance on a force plate using center-of-pressure trajectory and the Star Excursion Balance Test (SEBT). . Dancers demonstrated better balance on both instrumented and non-instrumented outcome variables: wide base of support with eyes open and with eyes closed; for 30-second single limb stance with eyes open and with eyes closed; for 13-second dual task in single limb stance; and for 22-second dual task in wide base of support .

The SEBT revealed significantly better balance performance of dancers in the three directions tested: anterior, posteromedial, and posterolateral. There was also a strength component of the study on which the dancers achieved significantly higher scores than controls for the three muscle groups tested (gastrocsoleus, gluteus medius, and quadriceps), which can be attributed to their training. They concluded that Indian classical dance forms involve interaction between the visual system (bhavang), vestibular system (chakkars, or spins), and proprioceptive system (tatkara, or footwork). As a result of the engagement of these three systems, which are considered to be an important element of the neuronal system in achieving balance Indian classical dancers demonstrated greater standing balance performance than age-matched non-dancers.

In a study conducted by Vrushali P. Panhale , Prachita P. Walankar and Aishwarya Sridhar they focused on the evaluation of the differences in posture between female Bharatanatyam dancers and age matched female non-dancers. . A cross-sectional study was conducted in 40 female Bharatanatyam dancers and 40 age-matched female non-dancers in the age group of 18 to 30 years. Analysis of erect standing posture of dancers and non-dancers was conducted in a reserved environment using a photogrammetric method. Static photographs of the subjects were taken in the sagittal plane. The measurement of the angles of the digitized photographs was performed using KINOVEA 0.8.15 software. Head protrusion angle, cervical lordosis angle, thoracic kyphosis angle, lumbar lordosis angle, and pelvic tilt angle were evaluated .From the study it was concluded that as significant differences were identified between the dancers and non-dancers for lumbar lordosis ($p = 0.00$) and pelvic tilt ($p = 0.00$) using independent t test with dancers. Higher values of lumbar lordosis and pelvic tilt were observed in bharattnatyam dancers.

IV. CONCLUSION

This study concludes thattheir is no correlation between the dynamic balance and pelvic inclination (increased)) in female bharatnatyam dancers.

V. CLINICAL IMPLICATION

- As it was found that most of the female bharatnattyam dancers were having increased lumbar lordosis which may lead to back pain in later life, to avoid that exercises can be given to the dancers during their warm up.
- People having affected dynamic balance can be adviced to join bharatnnatyam classes as it will help them improve balance.

VI. LIMITATION OF STUDY

Study was conducted covering a small area only.

VII. RECOMENDATION AND FUTURE SCOPE OF STUDY

- A detailed study can be conducted on a larger population for further intervention.
- A study can be done on the balance training done by bharatnatyam dancers as the dancers have remarkable dynamic balance despite of increased pelvic inclination
- As posture is one of the factor affecting the dynamic balance and this study shows that their is no correlation between increased lumbar lordosis and dynamic balance, further study can be done to understand exactly which factor affects the dynamic balance the most.
- Also study can be done on male bharatnatyam dancers.

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