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## Correlation of Degree of Toe Out and Anterior Knee Pain in Bharatanatyam Dancers.

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### ABSTRACT

Anterior knee pain is one of the common knee injuries in dancers. It is a repetitive strain injury, with incidence of 33% of dancers. Bharatanatyam is an Indian classical dance form which has semi squatting with foot in toe out position called Aramandi. Aramandi position exerts pressure on knee, which could be a reason for anterior knee pain. Therefore screening of dancers is necessary to identify musculoskeletal problems in dancers. The main purpose of this study was to find out the correlation of toe out and anterior knee pain. 50 Bharatanatyam dancers were included in the study. Their degree of toe out, and hip external rotation was measured. They were asked to answer Kujala questionnaire and pain score was taken. The correlation coefficient between VAS and Kujala was 0.0001, VAS and compensated toe out was 0.3183, and Kujala and compensated toe out was 0.5677. There was no association found between VAS and toe out, Kujala and toe out. Our study concluded that there is no correlation between the degree of toe out and anterior knee pain in dancers. Learning Bharatanatyam does not cause knee injuries.

**Keywords:** Anterior Knee Pain, Bharatanatyam Dancers, Aramandi, Kujala Questionnaire, Degree of Toe Out.

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## INTRODUCTION

Bharatanatyam is one of the graceful and the most popular form of Indian classical dance.<sup>1</sup> Dancers of all forms have challenging movements. Their training, choreography and performances require strength, stamina, flexibility, grace, passion, and emotion. Bharatanatyam dancers have two movements in their dance forms that are similar to squatting - a half-sitting pose and a full-sitting pose. Dancers sit in a particular position like half squat position called as Aramandi. This posture there is closed chain knee flexion with hip abduction and external rotation. In order to correctly execute this posture Aramandi, the dancer has to sit as deeply as she can while still keeping her back straight, feet together in a V-formation, heels on the floor, legs rotated outwards, and knees spread apart. In Muzumandi, the same posture is maintained, but the heels come off the floor as the dancer fully squats. In both of these postures, there is forces acting on both the knees, lumbar region and the ankle.<sup>2</sup>

Bharatanatyam dancers are more prone to lower limb injuries due to their posture. Knee, ankle and back injuries are most common among them. Injuries have become a great threat to the dancers just as in the case of athletes and sports persons. In relation to these injuries of the dancing style we need to evaluate the consequential changes happening in the dancers, thereby preventing further damages.<sup>3</sup>

Patellofemoral pain is an overuse injury characterized by aching pain in the peripatellar region that is exacerbated by physical activities such as climbing stairs, squatting, jumping, and running and or by sitting with the knees flexed for prolonged periods of time<sup>4</sup>. A combination of factors, such as abnormal lower limb biomechanics, soft-tissue tightness, muscle weakness, and excessive exercise may result in increased cartilage and sub chondral bone stress and subsequent Patellofemoral pain syndrome. This is clear that the etiology of patellofemoral pain syndrome is multifactorial in nature. There are evidences to show association between patellofemoral pain syndrome and patellar alignment and mechanics, foot mechanics, and hip strength and mechanics.<sup>5</sup>

So the purpose of this study was to observe degree of toe out, to identify if Bharatanatyam dancers had anterior knee pain due to their semi squatting position and toe out.

## MATERIALS AND METHOD

A study with a cross sectional study design was done on 50 subjects through non probability sampling for a period of 3 months.

Males and females aged between 18 to 30 years, practicing Bharatanatyam dance form for at least 1 year, 2 or more hours per week were recruited in the study. Subjects with any form of knee or ankle pathologies were excluded from the study.

**Outcome Measures:**

Kujala scoring questionnaire (anterior knee pain scale) (Reliability is 0.95) Visual analogue scale. Degree of toe out

**Kujala Scoring Questionnaire**

It has 13 knee specific self-report questionnaire. It was given by Kujala et al in 1993 and Timm in 1998. It documents response to activities specifically associated with anterior knee pain syndrome. Scoring was done for 100. Lesser the scoring greater is the pain or disability.<sup>9</sup>

**Visual Analogue Scale:**

VAS is a horizontal line, 100 mm in length, anchored by word descriptors at each end. The patient marks on the line the point that they feel represents their perception of their current state. The VAS score is determined by measuring in millimeters from the left hand end of the line to the point that the patient marks.<sup>10</sup>

**Degree of Toe – Out Functional turn out:**

The toe-out angle is defined as the degree of external rotation of the foot with respect to the direction of progression.<sup>6</sup>

**PROCEDURE:**

An approval was obtained from the institutional ethical committee. All subjects were screened for their inclusion and exclusion criteria before their recruitment in the study. A written informed consent was obtained from the study subjects. Questionnaires were distributed.

Degree of toe out was measured by asking the subject to stand on a white paper and assume the position which they assume in their dance class. A tracing was made around their feet. The angle bisecting the longitudinal arches of the foot was measured using a universal goniometer. This was functional turnout angle. Hip external rotation was measured by asking the subject to sit in high sitting position. Then the subject's passive hip external rotation was measured using universal goniometer. This was taken bilaterally.



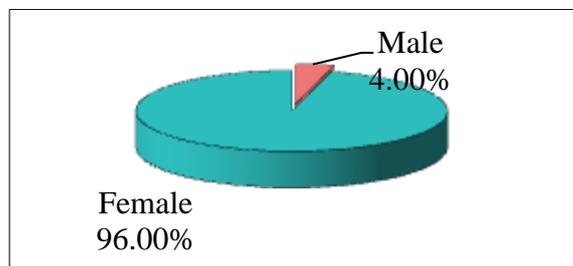
**Figure 1: Degree of toe**

### Measurement of Compensated Turnout Angle:

It was obtained by calculating the difference between the functional turnout and total passive hip external rotation.<sup>11</sup>

### RESULTS AND DISCUSSION:

Pie chart graph showing the distribution of male and female subjects.



**Graph 1: Distribution of male and female patients**

**Table 1: Normality of different variables in the study by Kolmogorov Smirnov test**

Variables	Z value	P Value
No of years of dancing	1.1240	0.1600
BMI scores	0.9710	0.3020
VAS scores	2.1730	0.0001*
Kujala scores	1.5800	0.0140*
Compensated toe out	1.4550	0.0290*

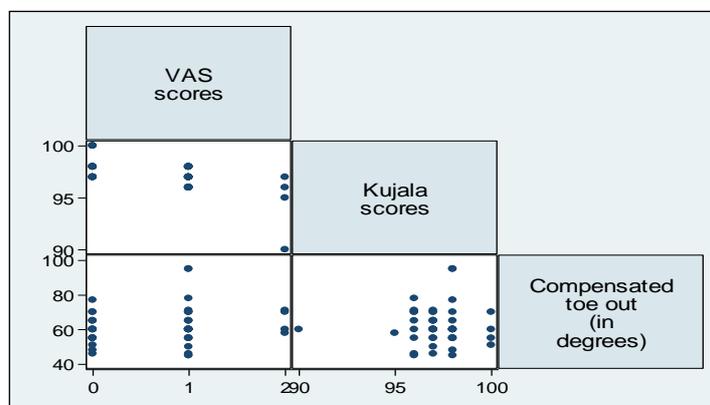
\*p<0.05

The p values of VAS, Kujala and compensated turn out is <0.05, hence they are statistically significant.

**Table 2: Correlation between VAS, Kujala, and Toe out scores by Spearman's rank correlation coefficient method.**

Correlations between	Spearman's R	t-value	p-value
VAS and Kujala scores	-0.5360	-4.3985	0.0001*
VAS and Compensated toe out	0.1440	1.0084	0.3183
Kujala and Compensated toe out scores	-0.0828	-0.5754	0.5677

\*p<0.05



**Graph 2: Correlation between VAS, Kujala, Toe out scores by Spearman's rank correlation coefficient method.**

The p value of VAS and Kujala is  $<0.05$ . So they are correlated.

The graph shows a negative correlation between VAS and Kujala score.

The p value of VAS vs. compensated toe out is  $>0.05$ .

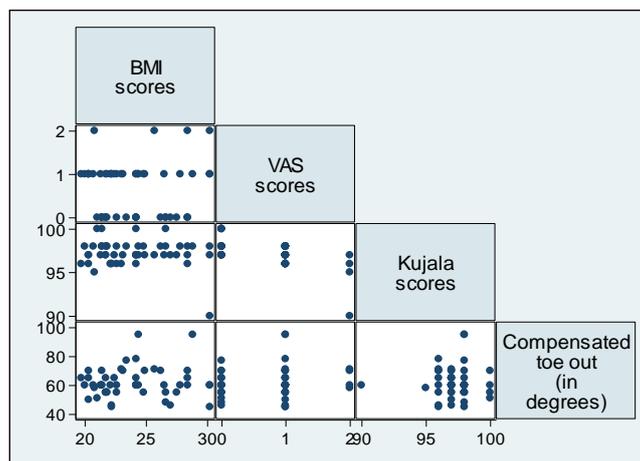
The graph between VAS and Compensated toe out is not following the linear pattern. Hence VAS and Compensated toe out is not Correlated.

Similarly, the p value of Kujala score vs. compensated toe out is  $> 0.05$ .

Graph also shows a scattered model between Kujala and compensated toe out. Therefore there is no correlation between toe out and anterior knee pain.

**Table 3:Correlation between BMI with VAS, Kujala, and Toe out scores by Spearman's rank correlation coefficient method.**

Variables	Correlation between BMI scores with		
	Spearman's R	t-value	p-value
VAS scores	-0.0048	-0.0330	0.9738
Kujala scores	0.0449	0.3114	0.7569
Compensated toe out in $^{\circ}$	0.0672	0.4670	0.6426



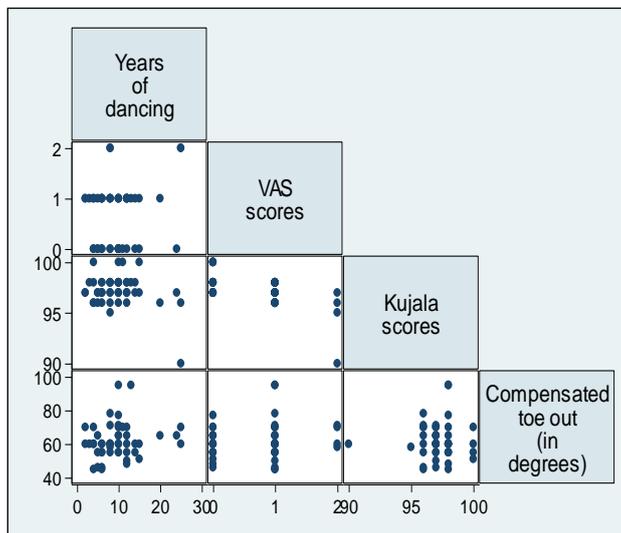
**Graph 3: to show correlation between BMI with VAS, Kujala, Toe out scores by Spearman's rank correlation coefficient method.**

The p value of BMI with VAS, Kujala and compensated toe out is not significant.

The graph is not following the linear pattern. Hence there is no correlation between BMI and VAS, BMI and Kujala, BMI and compensated toe out.

**Table 4: Correlation between years of dancing scores with VAS, Kujala, and Toe out scores by Spearman's rank correlation coefficient method**

Variables	Correlation between years of dancing scores with		
	Spearman's R	t-value	p-value
VAS scores	0.0643	0.4462	0.6575
Kujala scores	0.0047	0.0324	0.9743
Compensated toe out in $^{\circ}$	0.1705	1.1991	0.2364

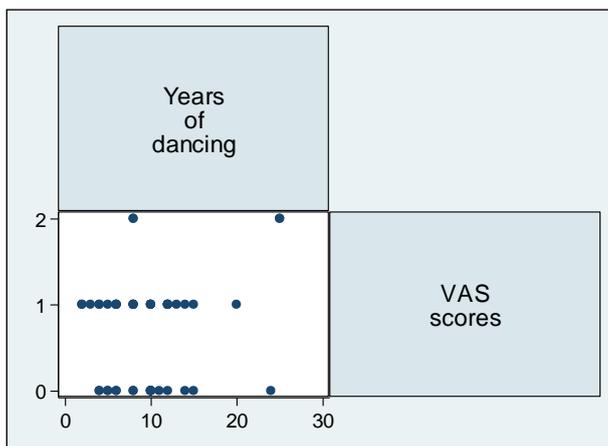


**Graph 4: Correlation between years of dancing scores with VAS, Kujala, Toe out scores by Spearman’s rank correlation coefficient method.**

The p value of No. of years of dancing with VAS, Kujala and compensated toe out is not significant. The graph is not following the linear pattern. Hence there is no correlation between No. of years of dancing and VAS, No. of years of dancing and Kujala, No. of years of dancing and compensated toe out.

**Table 5: Correlation between years of dancing scores with BMI scores by Karl Pearson’s correlation coefficient method.**

Variables	Correlation between No. of years of dancing scores with Spearman’s R	t-value	p-value
BMI scores	0.1051	0.7323	0.4675



**Graph 5: Correlation between years of dancing scores with BMI scores by Karl Pearson’s correlation coefficient method.**

The p value is not significant for No. of years of dancing and BMI. The graph is not following the perfect linear relationship. Hence No. of years of dancing and the VAS score are poorly correlated.

## DISCUSSION:

This study is done on 50 healthy Bharatanatyam dancers. Statistical analysis showed poor correlations between degree toe out and anterior knee pain.

A study was done by Preston J. Smith et al, on 1365 amateur and 900 professional ballet dancers. The incidence of injury among amateur dancers was 0.99 and 1.09 injuries per 1000 dance hours in males and females, respectively. 75% of injuries were overuse injuries. The incidence of injury was 1.06 and 1.46 injuries per 1000 dance hours in males and females, respectively. 64% of female injuries were overuse, compared with 50% in males. It showed 29% of prevalence of patellofemoral pain in dancers.<sup>12</sup>

A study was done by V. Anbarasi, David V Rajan and Adalarasu. Their results showed that injured female Bharatanatyam dancers had significantly high hamstring tightness at left side as of lower extremity compared to normal female dancer. Lower Extremity Muscle Flexibility problem arising from musculoskeletal disorders in injured and normal dancers have been well documented among south Indian Bharatanatyam dancers. Observational results showed that Iliotibial Band muscle tightness was high and quadriceps muscle tightness was low in normal male and female dancer when compared to injured dancers. This result concluded that injured dancers have muscle tightness problem which may lead to MSD during his/her dancing carrier. Injured dancer have high hamstring tightness that lead to pain and MSD.<sup>2</sup> This is one of the study that is contradicting our study.

Anterior knee pain could be due to a combination of factors, such as abnormal lower limb biomechanics, soft-tissue tightness, muscle weakness, and excessive exercise may result in increased cartilage and sub chondral bone stress and subsequent Patellofemoral pain syndrome. This is clear that the etiology of patellofemoral pain syndrome is multifactorial in nature.<sup>5</sup>

Poor correlation in our study is been supported by a study done by Alison Chang et al. It showed that the greater the degree of toe out, there was reduced likelihood of progression of osteoarthritis knee. It also supports that age, gender, or BMI is not affecting the anterior knee pain.<sup>6</sup>

Bharatanatyam dancers have to maintain squatting position almost throughout their performance. According to a study done by Harley, Yolande X. R et al, the dancers had greater quadriceps muscle strength than the controls. So this could be another reason that the dancers might not be experiencing anterior knee pain. Therefore there may be a poor correlation for anterior knee pain.<sup>7</sup>

A study was done by James R. Roush, and R. Curtis Bay to find the prevalence of anterior knee pain in the age group of 18 to 35 year old females. The overall prevalence rate of

anterior knee pain for females in the general population was only 0.12. This result also supports our study for poor correlation of anterior knee pain. <sup>8</sup>

#### **Limitations:**

Only 2 male subjects could be included in the study as male Bharatanatyam dancers were not available.

#### **FUTURE SCOPE OF STUDY:**

This can be done on other dance forms which has knee squatting postures. Other outcome measures like Knee flexion range of motion can be added.

Study on lumbar lordosis can be done in Bharatanatyam dancers as they have an exaggerated lordosis. A study on shoulder strength can be done as they always have their shoulders in abducted position.

#### **CONCLUSION:**

The findings of this study concludes that there is poor correlation between the toe out and anterior knee pain among Bharatanatyam dancers. Most of the subjects had VAS score less than 1. And Kujala scoring for anterior knee pain was more than 95. Statistical analysis also showed that there was no correlation between anterior knee pain and toe out. Where both suggest that there is very minimal or no knee pain among the Bharatanatyam dancers.

#### **ABBREVIATIONS:**

VAS: Visual Analogue Scale

BMI: Body Mass Index

MSD: Musculo Skeletal Disorders.

#### **ACKNOWLEDGEMENTS:**

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