

# The correlation between generalized joint hypermobility and musculoskeletal disorders in female dancers



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## ABSTRACT

**Background:** Bali is a popular tourist destination because of its unique culture. One of its unique features is the Balinese dance, which is used to welcome guests, perform arts, and perform religious ceremonies. Many Balinese dancers experience generalized joint hypermobility (GJH) without realizing it, which may have a negative impact on them, especially if they have a problem of musculoskeletal pain.

**Methods:** This research used an analytical observational design of a cross-sectional study. This study employed the sampling technique of purposive technique with a total sampling method. The inclusion criteria for this study were traditional Balinese dancers living in Denpasar city, female, aged 14-20, and having dancing experience more than 1 year. Exclusion criteria were subjects after surgery for fractures or other musculoskeletal injuries in the upper or lower extremities, subjects with signs of acute inflammation in the joints, and those unwilling to be research subjects. The number of samples was calculated using the lame show formula, and 85 samples were obtained. Data was collected by measuring GJH and musculoskeletal disorders using the Nordic body map questionnaire.

**Results:** Based on the bivariate analysis test with Spearman's rho,  $p$ -value = 0.000 ( $p < 0.05$ ) was obtained for the two independent variables with a correlation coefficient of  $r = 0.797$ .

**Conclusion:** Based on the research results, it can be concluded that there is a relationship between GJH and MSDs in the Balinese dancer population in Denpasar City.

**Keywords:** Balinese dancers, female, generalized joint hypermobility, musculoskeletal disorder.

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## INTRODUCTION

Indonesia is rich in culture and customs, including traditional dance. Bali, with its diversity of dances, is one of the provinces with the most traditional dances. Balinese dance is recognized by UNESCO as a world cultural heritage and is a significant tourist attraction.<sup>1</sup> The development of tourism in Bali encourages economic improvement in the community. One of the main attractions is the traditional Balinese dance performance. Professional dancers perform aesthetic movements that demand high flexibility and joint mobility. This often results in musculoskeletal disorders (MSDs) in dancers.<sup>2</sup>

The prevalence of musculoskeletal disorders in Indonesia among people aged 15 years and above reached 24.7%, where the highest prevalence was 33.1%

in East Nusa Tenggara, followed by West Java (32.1%), Bali (30%), and South Sulawesi (27.7%) (Ministry of Health of the Republic of Indonesia, 2013). The prevalence of previous research on 260 dancers found that as many as 81% of dancers experienced musculoskeletal disorders in professional ballet dancers 54.8%, and modern dancers 46.3%. Another study on 42 breakdance dancers found that 20 dancers (95.2%) experienced musculoskeletal disorders in more than one area since they started dancing.<sup>3</sup>

MSDs are disorders of skeletal muscles resulting from repeated static loads over a long period of time.<sup>4</sup> This repetitive activity can damage muscle tissue and cause pain. Dancers, like athletes, also experience pain due to movements that exceed certain limits of tolerance and repetition, putting them at risk of minor

and major injuries.<sup>5</sup> One of the factors causing disorders of MSDs in dancers is joint hypermobility (GJH). GJH is an excessive range of motion that occurs in a joint. This condition allows dancers to achieve aesthetics in dance but risks causing MSDs disorders. The prevalence of GJH in dancers is higher than in the general population, with the highest prevalence in girls aged 14-20 years.<sup>6</sup>

This study examines the relationship between GJH and MSDs in Balinese dancers in Denpasar City. Asymptomatic and untreated GJH can cause symptomatic GJH, which hinders a dancer's performance until early retirement.<sup>7</sup> GJH can also cause early osteoarthritis (OA). Therefore, it is important to understand the relationship between GJH and MSDs in Balinese dancers to prevent and manage musculoskeletal disorders.<sup>8</sup>

## METHODS

This research used a cross-sectional analytical study design. The sampling was conducted from December 2023 to January 2024 using a non-probability sampling technique. The sample in this research was traditional Balinese dancers. Inclusion criteria were traditional Balinese dancers living in Denpasar city, female, aged 14-20, and having dancing experience > 1 year. The exclusion criteria were subjects after surgery for fractures or other musculoskeletal injuries in the upper or lower extremities, subjects with signs of acute inflammation in the joints, and those unwilling to be research subjects.

GJH was measured using the beighton score, which has a high sensitivity and specificity value of 90%, an intra-rater reliability value of 0.81, and an inter-rater value of 0.75, and musculoskeletal disorders were measured using the Nordic body map with a reliability value 0.821, resulting in 85 samples. The GJH grading categories are Light 0-4, Medium 5-6, and Heavy 7-9. The MSDs assessment categories are as follows: 1 with a total score  $\leq 28$  = (No Risk/Complaint), 2 with a total score = 29-49 (Low), 3 with a total score = 50-70 (Medium), 4 71-91 (Heavy), 5 with a total score of 92-112 (Very Heavy).

Data analysis used SPSS, and the data obtained was analyzed using Spearman Rho. After a thorough study, this research received approval from the Ethics Commission of the Faculty of Medicine, Udayana University, with Decree number 2557/UN14.2.2.VII.14/LT/2023. Each participant voluntarily agreed to participate in the research, giving his consent. Next, participants signed an informed consent document indicating their understanding of the study aims, procedures, and possible risks.

Univariate analysis was used to describe the characteristics of the research subjects for each variable. The variables analyzed by researchers were age, training

frequency (years), GJH, MSDs. The linear regression test was used to determine the effect of the independent variable on the dependent variable.

## RESULTS

Based on Table 1, the distribution table of sample characteristics for the GJH category, 24 people experienced mild GJH, 42 experienced moderate GJH, and 19 experienced severe GJH. The age of the sample ranged from 14-20 years. Based on Table 2, showed the distribution table of characteristics of the MSDs category above. 14 people are not at risk of experiencing MSDs, 11 people are at low risk of experiencing MSDs, and 60 people are at moderate risk of experiencing MSDs.

The distribution of Table 3 shows the relationship between GJH and MSDs. Above 22 people who were not at risk experienced mild GJH in the MSDs category, and as many as two people were at low risk. There were 15 people with moderate GJH in the low MSDs category and 27 people with moderate risk. A total of 19 people experienced severe GJH, with seven people in the low MSDs category and 12 people in the moderate MSDs category.

Based on Table 4 The  $p$ -value obtained is  $0.000 < 0.05$ , so it can be concluded that this regression model is suitable for use and that the independent variable (GJH) influences the dependent variable (MSDs). From the results of the determination calculation, find out how much influence the independent variable has on the dependent variable. The coefficient of determination test results obtained R square with a value of 0.641. This shows the influence of the independent variable, namely GJH, on the dependent variable, namely MSD.

## DISCUSSION

Women had a higher GJH prevalence than men aged 14-20 years. This is due to several factors, including the collagen structure in the joints. Dancers have a percentage of up to 35% with GJH compared to the general population. A study conducted in Australia with a sample of 85 dancers proved that 76% of dancers experienced GJH, and most of it occurred in female dancers.<sup>8</sup>

The National Library of Medicine in the British Journal of Sports Medicine found that dancers who experience extreme GJH are an asset for a dancer. Still, this condition can cause the dancer to experience instability and injury due to

**Table 1.** Distribution of sample characteristics based on generalized joint hypermobility (GJH) categories

GJH Category	Frequency	Percentages (%)
Light	24	28.2
Currently	42	49.4
Heavy	19	22.4
Total	85	100

**Table 2.** Distribution of sample characteristics based on musculoskeletal disorders (MSDs) categories

MSDs Category	Frequency	Percentages (%)
No Risk	14	16.5
Low	11	12.9
Currently	60	70
Total	85	100

**Table 3.** Distribution of generalized joint hypermobility (GJH) in the musculoskeletal disorders (MSDs)

Variable MSDs GJH	$\leq 28$ No risk	29-49 Low	50-70 Medium	71-91 Heavy	92-112 Very heavy	Total
0-4 light	22	2	0	0	0	24
5-6 medium	0	15	27	0	0	42
7-9 weight	0	7	12	0	0	19
Total	22	24	39	0	0	85

**Table 4. Linear regression test results between the relationship between generalized joint hypermobility and musculoskeletal disorders**

Correlation	p-Value	Correlation Variable
Regression	0.000	0.641

poor joint stabilization. Epidemiological studies show that the fatigue and bone health experienced by individuals with GJH indicate they are more susceptible to injury than other normal dancers.<sup>9,10</sup>

Dancers with GJH usually have high joint flexibility. Because of this, they tend to use excessive movement in the joint area at the elbow, which can cause additional stress on the surrounding muscles and tissues. So this makes dancers vulnerable to injury and pain in the shoulder and elbow areas. As in Table 2, it can be seen that dancers usually experience pain in the shoulder to the elbow area, both right and left.<sup>11</sup>

Biomechanical analysis in Balinese Dance can help identify factors at risk of causing injury, but this does not mean that this analysis directly causes injury. Injuries in Balinese dancers are generally caused by several factors, including improper technique, errors in dance technique, such as poor body posture, improper foot placement, and excessive force, which can cause excessive stress on the body, waist and increases the risk of injury.<sup>12</sup> Fatigue, muscle, and physical exhaustion can make dancers more susceptible to injury because their bodies cannot respond to stress well.<sup>13</sup> Poor physical condition, lack of strength, flexibility, and muscle endurance can make dancers more susceptible to injury because their bodies lack the strength and control to perform complex and energetic movements. History of injury: dancers with previous injuries, especially in the waist area, are more susceptible to re-injury.<sup>14</sup> Environmental factors, slippery stage conditions, poor lighting, and ill-fitting costumes can increase the risk of falls and injury.<sup>9,15</sup>

Table 3 shows the pain felt by dancers who experience GJH, with the highest category of pain from the upper extremities being the left upper arm in as many as 62 people and the right upper arm in as many as 41 people. This is because joints with GJH have looser capsules and ligaments, making them less unstable and susceptible to injury.<sup>16,17</sup> Repetitive microtrauma due

to repetitive dance movements can cause inflammation of the joint tissue, tendons, and muscles around the joints. This inflammation can trigger pain, swelling, and stiffness in the affected joints.<sup>14</sup> GJH can cause weakness in the surrounding muscles. Weak muscles cannot stabilize joints properly, increasing the risk of injury and pain. Muscle weakness can also cause more fatigue and pain during activity.<sup>18</sup>

The waist is one of the parts that experience the most pain, namely 48 people, because the structure of the bones and tissue in the waist area can differ for each individual. This difference can make someone more susceptible to pain in the lower back area than other people. Factors such as spinal deformities, spinal stenosis, and herniation of the nucleus pulposus can also increase the risk of low back pain in dancers. In Balinese dancers, the lumbar region is more lordotic.<sup>19</sup> Excessive lordosis causes the lumbar spine to curve inward, thereby increasing stress on the facet joints, intervertebral discs, and ligaments in the lumbar area. This excessive pressure can cause damage to these structures, inflammation, and pain. Excessive lordosis can cause muscle weakness in the abdominal area and lower back. These muscles play an important role in stabilizing the spine and help maintain good posture. The spine becomes more susceptible to injury and pain when these muscles are weak. Excessive lordosis often accompanies a muscle imbalance between the flexor (pull) and extensor (push) muscles in the hip and lower back areas. This imbalance can cause unstable posture, increase pressure on spinal structures, and trigger pain.<sup>20</sup>

Based on the findings from statistical analysis used spearman-rho in Table 4, it shows that there is a relationship that tends to be positive and quite strong and significant between the GJH variable and MSDs in adolescents aged 14-20 years in Denpasar City with a correlation coefficient test results of 0.797 and a p-value of  $0.000 < 0.05$ . The interpretation of the value of 0.797 indicates that the

higher a person experiences GJH, the greater the possibility of MSDs occurring in adolescents aged 14-20 years in the city of Denpasar. These results indicate that people who experience GJH tend to experience MSDs in Balinese dancers aged 14-20 years.<sup>5</sup>

Dancers with GJH often have greater joint flexibility than the average person. They tend to use excessive movement in joint areas such as the elbow, which can cause additional stress on the muscles and connective tissue around the shoulder. As a result, they are more susceptible to injury and pain in the shoulder area. Research shows they are usually susceptible to injury due to excess joint flexibility, which can result in joint instability. This instability can increase the risk of dislocation, subluxation, or ligament injury because the joint does not have enough support from connective tissue. This instability also causes excessive tension in muscles and ligaments, increasing the risk of inflammation, tendinitis, or bursitis.<sup>21</sup> People with GJH often have suboptimal or unstable movement patterns, which can increase the risk of injury when exercising or engaging in physical activity. Other factors such as genetics, level of physical fitness, and lifestyle may also influence the risk of injury in individuals with joint hypermobility.<sup>22</sup>

In Table 3, it was found that there were seven people with high GJH but low MSDs. This is because dancers with high GJH, good dance technique and excellent body awareness can control their movements more effectively, thereby minimizing stress on joints and tissues. Dancers with GJH and good dance technique have a lower risk of injury than those with poor technique. In addition, strong muscles around the joints can provide better stability and support, reducing the risk of injury.<sup>23</sup>

Dancers with GJH and good muscle strength have a lower risk of injury than those with poor muscle strength. Another factor is good proprioception, namely the body's ability to sense the position and movement of joints. It can help dancers with GJH control their movements more effectively and avoid high-risk positions.<sup>24</sup> Studies such as the effect of proprioceptive training on injury risk in dancers with



hypermobility by Myburgh et al. (2011), showed that dancers with GJH who participated in a proprioception training program had a lower risk of injury than those who did not participate in the program. Dancers with high GJH who practice good injury prevention habits, such as proper warm-up, cool-down, and stretching, can help reduce the risk of injury.<sup>5,12</sup>

Researchers have several limitations in this study, including using the cross-sectional method because data collection is only at one time and does not know or take into account the long term in research. The sample used was not specific, namely, which traditional Balinese dancers (traditional dancers for traditional ceremonies, dancers, or performers).

## CONCLUSION

All existing hypotheses can be accepted based on the research results using bivariate analysis. The following are the conclusions of this research, namely, there is a relationship between GJH and MSDs in Balinese dancers in Denpasar City, with a value of  $p = 0.000$  ( $p < 0.05$ ) for both variables with R Square = 0.641. This research shows a positive direction because the higher the score a person experiences GJH, the higher they experience MSDs.

## ETHICAL CLEARANCE

The Research Ethics Commission of the Faculty of Medicine, Udayana University, stated that this research was ethically feasible with number 2557/UN14.2.2.VII.14/LT/2023.

## CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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## AUTHOR CONTRIBUTIONS

PNS developed the research design, collected and processed data, and wrote the manuscript. NLPGKS, IMNW, and

IMAW directed data collection and revised the manuscript.

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