Duration of Training and the Incidence of Lumbar Hyperlordosis in Balinese Dancers: A Cross-Sectional Study at SMKN 5 Denpasar

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Abstract

Introduction: Mastering dance techniques requires prolonged training with repeated practice to achieve optimal movement before progressing to the next stage of the dance. Balinese dance involves a unique posture distinct from daily postures, known as *cengked*, where the chest is pushed forward. This position causes the body to lean more toward the anterior side. This study aims to examine the relationship between the duration of dance training—measured by training duration, frequency, and onset—and the incidence of lumbar hyperlordosis at SMKN 5 Denpasar.
Methods: This study employed an analytical observational design with a cross-sectional approach, using purposive sampling for participant selection. A total of 72 participants were included in the study. Data collection involved assessing the duration, frequency, and onset of dance training through a questionnaire and measuring lumbar lordosis curvature using a flexicurve ruler.
Results: The Chi-square test showed a p-value of <0.001. Further analysis using the Phi correlation coefficient indicated correlation values of 0.501 for duration, 0.527 for frequency, and 0.616 for onset, suggesting moderate to strong relationships.
Conclusion: The findings indicate a significant relationship, with moderate to strong correlations, between the duration, frequency, and onset of dance training and the incidence of lumbar hyperlordosis at SMKN 5 Denpasar. A limitation of this study is using the flexicurve ruler as a measurement tool, as manual assessment may introduce measurement bias.

Keywords: lumbar hyperlordosis, dance training, Balinese dancers

Introduction

Balinese dance, recognized as a world cultural heritage, is one of Bali's key attractions, drawing many visitors interested in learning the art form. Balinese dance education is also incorporated into school curricula as part of the government's cultural preservation efforts.[1] According to Dibia (2013), executing dance movements requires mastering fundamental body postures known as *adeg-adeg*. These basic movements in Balinese dance consist of four interrelated and influential elements: head movements, body posture, hand positioning, and foot placement. The dancer's posture is meticulously maintained from head to toe to achieve the proper form. In addition to posture, precise technique shapes the body's curves during Balinese dance.[2]

Balinese dance features a distinctive posture known as *cengked*, in which the chest is pushed forward (curved at the torso). In female dances (*tari putri*), the shoulders are in a normal position and the hips are often pulled back, forming a forward curvature of the lower back to create a soft and feminine impression.[2] This posture causes the body to lean more toward the anterior side.[3] Mastering dance techniques requires prolonged training with repetitive practice to perfect movements before progressing to the next stage.[4] According to the World Health Organization (2010), the recommended training duration for individuals aged 5 to 17 years is 60 minutes per session, with a training frequency of three to five days per week to maximize health benefits.[5]

As a physically active group, dancers frequently perform movements that involve an excessive range of motion in the lumbar region.[6] Lumbar lordosis is an essential component in maintaining sagittal balance.[7] It begins developing when infants start standing (between 12 and 18 months of age) and continues until spinal growth is complete, typically between 13 and 18 years.[8] But a recent study revealed that spinal maturation generally occurs between the ages of 21 and 25.[9] The normal lordotic curve ranges between 20° and 40°, while hyperlordosis is diagnosed when the lumbar curvature exceeds 40°.[10–12] In a normal curve, the facet joints bear between 0% and 33% of the load, depending on an individual's posture. However, in hyperlordosis, continuous loading increases facet joint stress to as much as 70%, potentially leading to disc degeneration.[13]

Hyperlordosis is a common postural issue that affects aesthetics and poses long-term health risks.[14] A study by Bajaj and Anandh (2020) in India found that 45% of women aged 35–45 exhibited hyperlordosis.[15] Similarly, Lemos et al. (2012) reported that 78% of 467 students in Brazil had hyperlordosis.[16] Individuals with lumbar hyperlordosis are 17 times more likely to experience severe pain intensity in cases of low back pain.[17]

Dancers' health concerns warrant attention for several reasons. Repetitive movements without adequate rest can lead to musculoskeletal issues due to muscle fatigue from sustained mechanical stress.[18] If prolonged, such activities can result in cumulative trauma, which likely arises from insufficient adaptive changes to counteract the biomechanical effects of prolonged exposure to uncomfortable postures.[19] Extended exposure to high mechanical loads may also affect the morphology of the developing spine, potentially disrupting structural growth and mechanical strength.[20] A study by Wojtys et al. (2000) found that lumbar lordotic curvature increases significantly when training exceeds 400 hours per year.[21] Similarly, Ambegaonkar et al. (2014) observed that dancers and gymnasts with higher cumulative training hours exhibited greater sagittal spinal curvature. Increased training duration and frequency contribute to more significant mechanical loading on the spine, which can exacerbate lumbar lordosis when combined with the extreme range of motion required in dance.[6]

Hyperlordotic postures, such as those seen in gymnastic movements, place excessive stress on the lumbar spine's facet joints and intervertebral discs.[22] This assertion is further supported by Skallerud et al. (2022), who found a correlation between increased lumbar lordosis and dancers' postures.[23] Dancers are prone to developing increased lumbar lordotic curvature due to postural habits and movement patterns associated with dance.[24] Research by Wiraputri et al. (2022) revealed a high prevalence of lumbar hyperlordosis among Balinese dancers, with 79.5% of participants exhibiting the condition.[18]

The studies above indicate a relationship between dance training and lumbar lordotic curvature. However, no specific research has examined the role of training duration, frequency, and onset as risk factors. Therefore, this study aims to investigate the relationship between training duration (minutes per session), training frequency (days per week), and training onset (years of experience) with the incidence of lumbar hyperlordosis among Balinese dancers at SMKN 5 Denpasar. This study hypothesizes that training duration, frequency, and onset are significantly associated with lumbar hyperlordosis.

Methods

This study employed an analytical observational research design with a cross-sectional approach using purposive sampling. The cross-sectional design was chosen as it allows for observing the relationship between risk factors and outcomes at a single point, making it more time- and cost-efficient than cohort studies, which require long-term follow-up. A case-control design was also not used because this study focuses on direct measurement rather than a retrospective search for risk factors.

Purposive sampling was selected to ensure the data obtained was relevant and accurate, allowing researchers to choose specific individuals from the target population based on the study's objectives, time availability, and resource constraints. However, since subject selection is based on predetermined criteria, this method may limit population diversity, potentially reducing the generalizability of the findings.

The independent variables in this study were training duration, training frequency, and dance training onset, while the dependent variable was the lumbar lordosis curve. Body Mass Index (BMI), age, and gender were controlled variables. The study was conducted in the UKS room at SMK Negeri 5 Denpasar during May and June 2024. The research subjects were active female students from the Dance Arts Department at SMK Negeri 5 Denpasar, aged 15–17 years, with a minimum of one year of dance experience, a regular training frequency of at least once a week in the past three months, and a BMI classified as underweight, regular, or overweight based on Z-score categories. Participants voluntarily took part in the study with parental or guardian consent.

The age classification of 15–17 years was based on the cut-off point from Kusumowati & Noerfitri (2023),[25] while BMI classification followed the cut-off points from the National Report of RIKESDAS (2018) and the Indonesian Ministry of Health Regulation No. 2 (2020).[26,27] BMI categories for individuals aged 5–18 years were: underweight (< -3 SD), thin (-3 to < -2 SD), regular (-2 to +1 SD), overweight (> +1 to +2 SD), and obese (> +2 SD). Participants classified as obese were excluded, as obesity is associated with hyperlordosis.[10] BMI was used solely as a sample selection criterion and was not analyzed as a dependent variable. Students with congenital diseases, trauma, or spinal injuries were also excluded.

The sample size was determined using Lemeshow's cross-sectional formula, yielding a minimum requirement of 63 respondents without accounting for dropouts. Of 222 students in the Dance Arts Department at SMKN 5 Denpasar, 72 met the inclusion and exclusion criteria.

The study began with an orientation session explaining each class's research process. A screening was conducted to ensure participants met the inclusion and exclusion criteria. Students who passed the selection were invited to participate, and informed consent was obtained from students and their parents or guardians.

Participants completed a questionnaire that collected demographic information and details on training duration (length of a single dance training session in minutes), training frequency (number of dance training sessions per week), and dance training onset (years of experience in Balinese dance). Training duration (≤ 60 minutes and > 60 minutes) and frequency (≤ 3 times and > 3 times per week) were categorized based on the cut-off points from Wiraputri et al. (2022)[18] and adapted from World Health Organization recommendations.[5] Dance training onset (< 10 years and ≥ 10 years) was also categorized according to Wiraputri et al. (2022).[18]

After completing the questionnaire, participants entered a designated examination room where their lumbar lordosis curve was measured and recorded using a flexicurve ruler. Measurements were conducted in the presence of a female teacher, a female physiotherapist responsible for the lordosis curve assessment, and a female research team

member accountable for recording the flexicurve ruler results. The individual measuring lordosis angles was blinded to the participants' training duration, frequency, and onset to minimize measurement bias.

The flexicurve ruler was chosen as the measuring instrument, as it has been used in a similar population by Wiraputri et al. (2022),[18] demonstrating intra-observer ICC reliability of 0.78 and inter-observer ICC reliability of 0.83.[28] A systematic review on the validity and reliability of non-radiographic methods has shown that the flexicurve ruler has high to very high reliability.[29] After tracing the lordosis curve onto paper, a straight line was drawn from L1 to L5 to determine the Lordosis Length (LL), and a perpendicular line from the highest point of the lumbar curve to the LL line was drawn to determine the Lordosis Width (LW). The lordosis angle was calculated using the formula $\theta = 4 \arctan[(2 \times LW)/LL]$.[7] A normal lordosis angle ranges from 20° to 40°, with hyperlordosis defined as an angle exceeding 40°.[10,12]
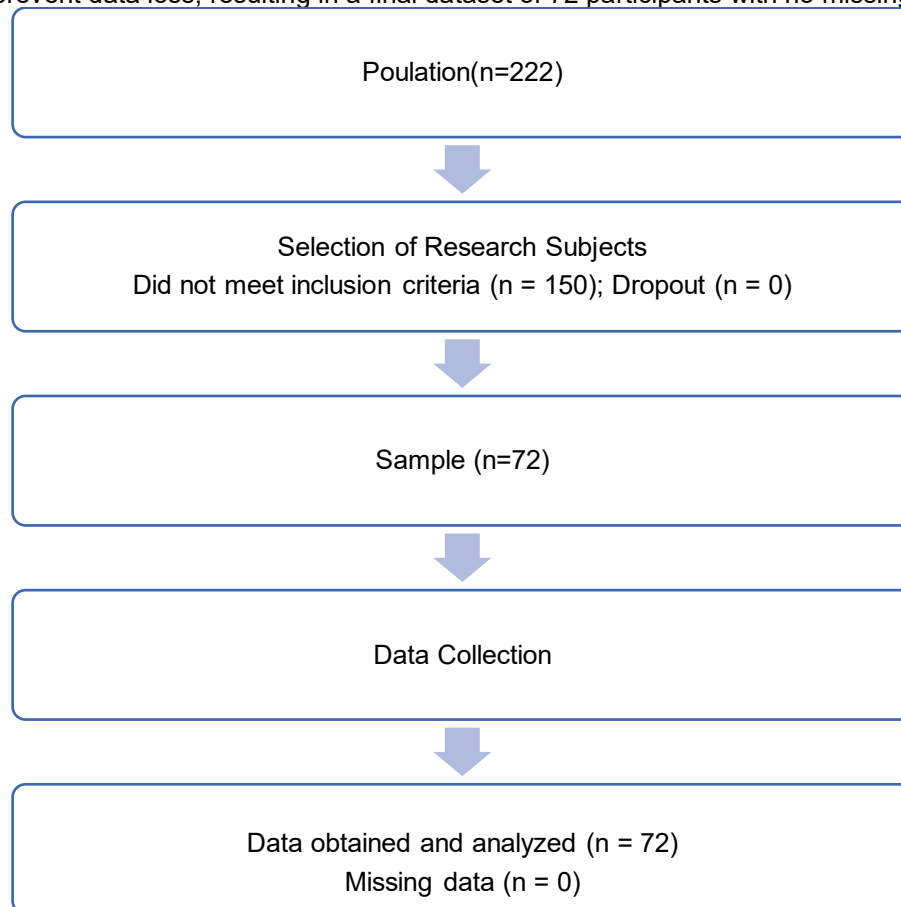
All collected data were checked for accuracy and analyzed using SPSS version 26.0. Univariate analysis described each variable's characteristics and frequency distribution, including age, BMI, lumbar lordosis curve, training duration, frequency, and onset. Bivariate analysis was conducted to test the hypothesis and examine the relationship between training duration, frequency, and onset with the incidence of lumbar hyperlordosis among Balinese dancers at SMK Negeri 5 Denpasar using the Chi-Square test. A Phi correlation test followed to determine the strength of the relationship between variables. The Chi-Square test assumptions were met. A significance level of 5% ($p < 0.05$) was used, and results were considered significant if the p-value was less than 0.05. No additional regression analysis was conducted to control for confounding variables; however, age, gender, and BMI were controlled through the inclusion and exclusion criteria.

This study received ethical approval from the Research Ethics Committee of the Faculty of Medicine, Udayana University, with ethical clearance number 1143/UN14.2.2.VII.14/LT/2024. Participant confidentiality was maintained, and data were used solely for research purposes. Participation was voluntary, with parental or guardian consent required. Participants had the right to decline to answer any question or withdraw from the study at any time without consequences.

Results

The sample in this study consisted of female students majoring in Traditional Dance at SMK Negeri 5 Denpasar, selected through purposive sampling. Out of a total population of 222, 72 participants met the inclusion criteria and were included in the analysis. One hundred fifty individuals did not meet the inclusion criteria due to parental disapproval, age, and gender incompatibility, failure to meet the minimum dance training onset, or having a BMI outside the specified range. No individuals dropped out or failed to complete the study as required.

Data were collected through questionnaire completion and measurements. All data were reviewed and verified before analysis to prevent data loss, resulting in a final dataset of 72 participants with no missing data.

Poulation(n=222)

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Selection of Research Subjects
Did not meet inclusion criteria (n = 150); Dropout (n = 0)

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Sample (n=72)

↓

Data Collection

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Data obtained and analyzed (n = 72)
Missing data (n = 0)

Figure 1. Research Flowchart

The respondent characteristics, including age, body mass index (BMI), dance training duration, training frequency, dance training onset, and lumbar lordosis curve, are presented in a frequency distribution table (Table 1).

**Table 1.** Frequency Distribution of Sample Characteristics

Characteristic Variable	Frequency (n)	Percentage (%)
Age (Mean±SD)	16.10±0.632	
15 years	11	15.3
16 years	43	59.7
17 years	18	25
BMI (Mean±SD)	-0.287±0.9540	
Overweight	6	8.3
Normal	63	87.5
Underweight	3	4.2
Dance Training Duration		
≤ 60 minutes	41	56.9
> 60 minutes	31	43.1
Dance Training Frequency		
≤ 3 times per week	38	52.8
> 3 times per week	34	47.2
Dance Training Onset		
< 10 years	26	36.1
≥ 10 years	46	63.9
Lumbar Lordosis Curve		
Normal	37	51.4
Hyperlordosis	35	48.6
Total	72	100

Table 1 shows that the study sample was predominantly 16 years old (n = 43, 59.7%), with a mean age of 16.10 years and a standard deviation of 0.632. The majority had a normal BMI (n = 63, 87.5%), with a mean Z-score of -0.287 and a standard deviation of 0.9540. Regarding dance training duration, 56.9% of participants trained for ≤ 60 minutes per session, while 43.1% trained for > 60 minutes. Regarding training frequency, 52.8% of participants trained ≤ 3 times per week, whereas 47.2% trained more than 3 times per week. The onset of dance training was < 10 years in 36.1% of participants and ≥ 10 years in 63.9%. Based on lumbar lordosis curvature, 51.4% had a standard curve, while 48.6% had hyperlordosis. A bivariate analysis using the chi-squared test was conducted to evaluate the relationship between dance training duration and the incidence of lumbar hyperlordosis, as shown in Table 2.

Table 2. Bivariate Analysis Using Chi-Square Test: Relationship Between Dance Training Duration and Lumbar Hyperlordosis Incidence

Training Duration (minutes)	Lumbar Curve		Total	p-*value*
	Normal	Hyperlordosis		
≤ 60	30 (41.7%)	11 (15.3%)	41 (56.9%)	
> 60	7 (9.7%)	24 (33.3%)	31 (43.1%)	< 0.001
Total	37 (51.4%)	35 (48.6%)	72 (100%)	

As shown in Table 2, the analysis yielded $p < 0.001$, indicating a significant relationship between dance training duration and the incidence of lumbar hyperlordosis among Balinese dancers at SMK Negeri 5 Denpasar. The distribution of this data is visualized in Figure 1.
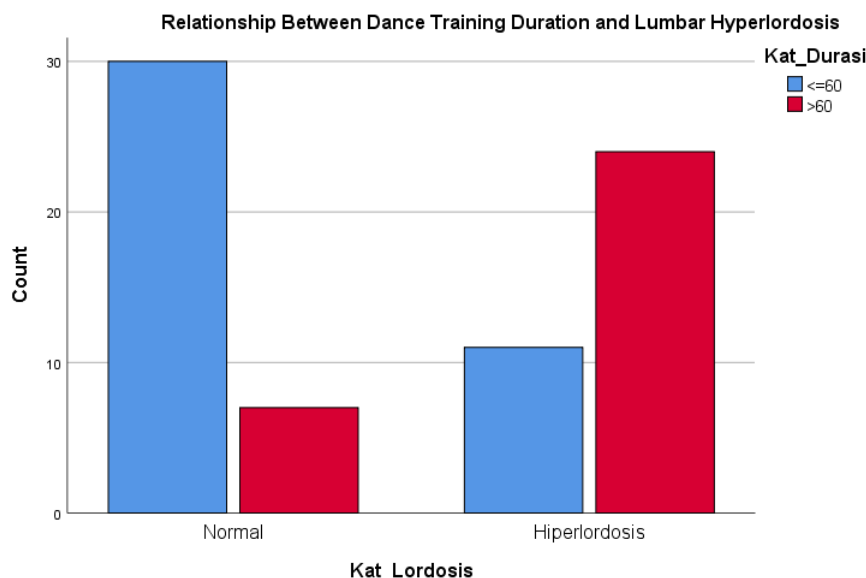
Figure 1. Graph of the Relationship Between Training Duration and Lumbar Hyperlordosis Incidence
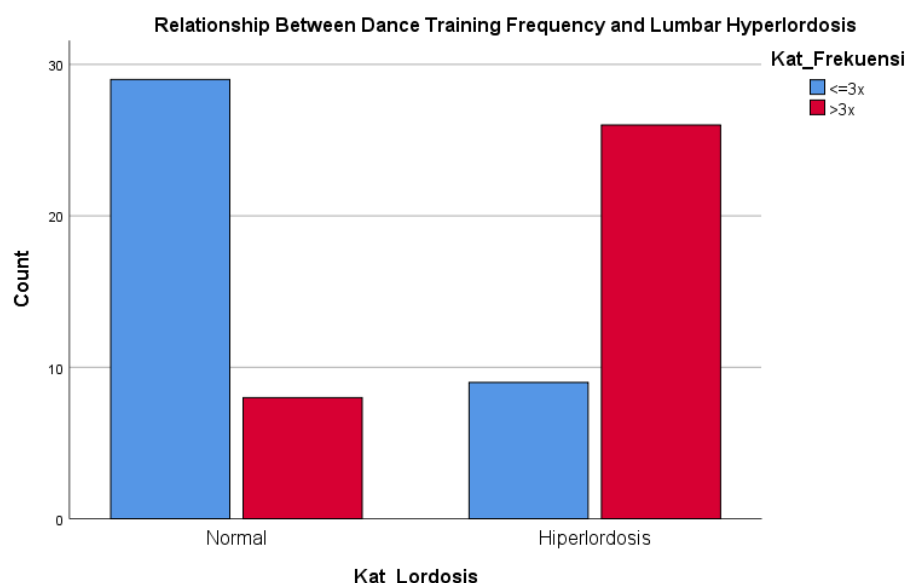
Table 3. Phi Correlation Test for Determining the Strength of the
Relationship Between Training Duration and Lumbar Hyperlordosis Incidence

Correlation Variable	Correlation Coefficient	p-value
Relationship between dance training duration and lumbar hyperlordosis incidence	0.501	< 0.001

Table 3 indicates a moderate correlation (r = 0.501) between dance training duration and the incidence of lumbar hyperlordosis. A bivariate analysis using the Chi-Square test was also conducted to evaluate the relationship between dance training frequency and lumbar hyperlordosis incidence, as shown in Table 4.

Table 4. Bivariate Analysis Using Chi-Square Test:
Relationship Between Training Frequency and Lumbar Hyperlordosis Incidence

Training Frequency (days per week)	Kurva		Total	p-value
	Normal	Hyperlordosis		
≤ 3x	29 (40.3%)	9 (12.5%)	38 (52.8%)	
> 3x	8 (11.1%)	26 (36.1%)	34 (47.2%)	<0.001
Total	37 (51.4%)	35 (48.6%)	72 (100%)	

Table 4 shows a significant relationship (p < 0.001) between training frequency and lumbar hyperlordosis incidence among Balinese dancers at SMK Negeri 5 Denpasar. The data distribution is visualized in Figure 2.

Figure 2. Graph of the Relationship Between Training Frequency and Lumbar Hyperlordosis Incidence

Table 5. Phi Correlation Test for Determining the Strength of the
Relationship Between Training Frequency and Lumbar Hyperlordosis Incidence

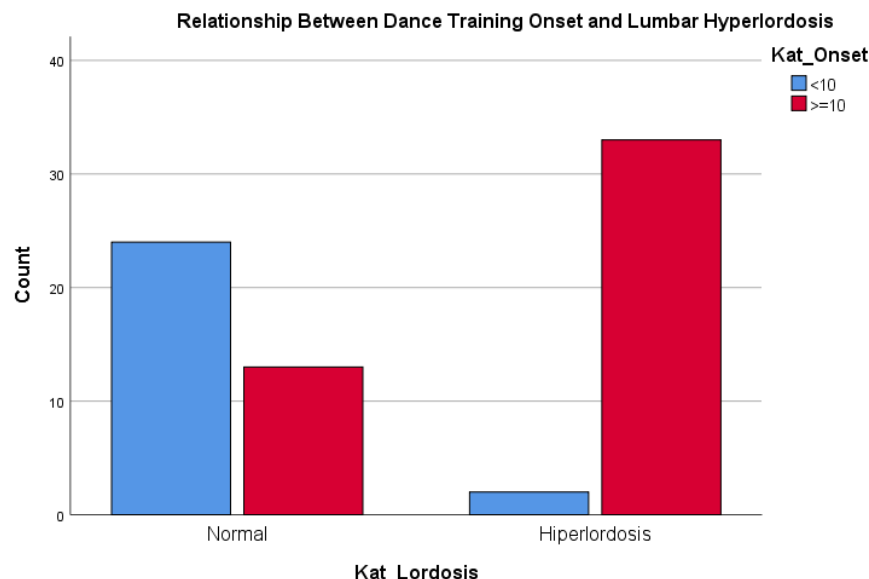| Correlation Variable	Correlation Coefficient	p-value
Relationship between dance training frequency and lumbar hyperlordosis incidence	0.527	<0.001

Table 5 indicates a moderate correlation (r = 0.527) between training frequency and the incidence of lumbar hyperlordosis. A bivariate analysis using the Chi-Square test was also conducted to evaluate the relationship between dance training onset and lumbar hyperlordosis incidence, as shown in Table 6.

Table 6. Bivariate Analysis Using Chi-Square Test:
Relationship Between Training Onset and Lumbar Hyperlordosis Incidence

Training Onset (years)	Kurva		Total	p-value
	Normal	Hyperlordosis		
< 10	24 (33.3%)	2 (2.8%)	26 (36.1%)	
≥ 10	13 (18.1%)	33 (45.8%)	46 (63.9%)	<0.001
Total	37 (51.4%)	35 (48.6%)	72 (100%)	

Table 6 shows a significant relationship (p < 0.001) between training onset and lumbar hyperlordosis incidence among Balinese dancers. The data distribution is visualized in Figure 3

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Figure 3. Graph of the Relationship Between Training Onset and Lumbar Hyperlordosis Incidence

Table 7. Phi Correlation Test for Determining the Strength of the
Relationship Between Training Onset and Lumbar Hyperlordosis Incidence

Correlation Variable	Correlation Coefficient	p-value
Relationship between dance training onset and lumbar hyperlordosis incidence	0.616	<0.001

Table 7 shows a strong correlation (r = 0.616) between training onset and lumbar hyperlordosis incidence.

Discussion
Characteristics of Research Samples

The sample collection was conducted twice, on May 17 and June 10, 2024, involving 72 active female students from the Dance Department at SMK Negeri 5 Denpasar who met the predetermined criteria. The sample consisted solely of female dancers due to several considerations. According to the distribution characteristics of dance research samples conducted by Christi et al. in 2021, most dance study participants were female.[30] Women have a greater lumbar angle than men when standing.[31]

In this study, most participants were 16 years old, totaling 43 individuals (59.7%). According to the Regulation of the Minister of Health of the Republic of Indonesia No. 25 of 2014, school-age children are those older than six years and younger than 18.[32] Based on 2023 data from the Bali Province Central Bureau of Statistics (BPS), the number of vocational high school (SMK) female students aged 15 and older was 160,192 out of 392,853.[33] In this study, most samples had a normal BMI, totaling 63 individuals (87.5%). Intensive dance training aids in fat burning and weight reduction, supporting BMI balance.[34]

Regarding training duration, this study was dominated by the ≤ 60-minute category, with 41 samples (56.9%). This result aligns with research by Wiraputri et al. in 2022, where most dancers trained for 0-60 minutes.[18] The WHO recommends that exercise be around 60 minutes for individuals aged 5-17.[5]

Examining the distribution of dance training frequency, there was no significant difference between the two categories. According to WHO recommendations, training frequency should be 3-5 days per week for individuals aged 5-17.[5] Mastering Balinese dance techniques requires prolonged and repetitive practice to achieve firm and well-formed movements, serving as a foundation for subsequent dance forms.[4]

The onset of dance training in this study revealed that most participants had been engaged in dance for ≥ 10 years, totaling 46 individuals (63.9%). This finding is consistent with the study by Wiraputri et al. in 2022, where most dancers belonged to the long-term category (≥ 10 years).[18] Given the relatively young age of the participants, this distribution reflects that they began dancing at an early age. To achieve expressive dance performances, dancers must start training early when their bodies are still flexible. One example of this is the Legong dance.[35]

Based on the distribution characteristics (Table 1), out of 72 participants in this study, 35 individuals (48.6%) experienced lumbar hyperlordosis, while the remaining 37 had standard lordotic curves. Similar results were found in the study by Rahmawati & Sidarta in 2021, where most participants exhibited normal curve distribution.[10] Although this study showed more participants with normal lumbar curvature, it does not rule out the possibility that dancers are at risk of developing lumbar hyperlordosis. This risk is supported by research by Wiraputri et al. in 2022 on the prevalence of lumbar hyperlordosis among dance students, where 79.5% of 44 participants (35 individuals) exhibited lumbar hyperlordosis.[18] Dancers tend to experience increased lumbar lordosis due to body positioning and certain postural habits compared to the non-dancer control group.[24] The extreme range of motion required in dance can contribute to increased lumbar lordosis.[6]

Relationship Between Dance Training Duration and Lumbar Hyperlordosis

Based on bivariate analysis using the Chi-square test (Table 2) and further correlation analysis using the Phi coefficient (Table 3), the results showed a p-value < 0.001 with a correlation coefficient of 0.501. This indicates a

significant moderate correlation between dance training duration and lumbar hyperlordosis among Balinese dancers at SMKN 5 Denpasar.

A study by Kayalı Vatansever et al. in 2023 on ballet dancers stated that fatigue is a common complaint in ballet dancers caused by repetitive training to achieve perfection. Long training times increase the incidence of injury. Fatigue that is associated with training load can lead to overuse injuries. Forced and repetitive movements of the trunk put stress on the musculoskeletal system of the spine. Due to weakness and imbalance of the muscles around the pelvis, abdomen and lumbar region, it becomes difficult to maintain the neutral position of the pelvis during movement which in this case can increase lumbar lordosis and trigger pain and degeneration of the spinal joints.[36]

Balinese dance requires strong technical mastery as a foundation for further development. Repetitive training helps shape a dancer's posture and refine technique. The posture required for Balinese female dancers differs from everyday posture, as the hips are frequently pulled back, forming an arch in the lower back and the shoulders are in a normal position.[2,4] Maintaining this non-ergonomic posture for extended periods increases the risk of musculoskeletal disorders. High-risk postures are unnatural and sustained for long durations with excessive inclination angles.[19] In a standard spinal curve, the facet joints bear between 0% and 33% of the load, depending on an individual's posture. However, in cases of hyperlordosis, the load on the facet joints can increase to 70%, potentially leading to disc degeneration.[13]

Relationship Between Dance Training Frequency and Lumbar Hyperlordosis

Bivariate analysis using the Chi-square test (Table 4) and the Phi correlation test (Table 5) resulted in a p-value < 0.001 and a correlation coefficient of 0.527. This signifies a significant moderate correlation between dance training frequency and lumbar hyperlordosis among Balinese dancers at SMKN 5 Denpasar.

This finding is consistent with research by Dewi & Satria in 2020 and Wiraputri et al. in 2022, which state that mastering Balinese dance requires prolonged and repetitive training to produce strong movements as a foundation for further dance development. Dance techniques are crucial in shaping a dancer's physique, ensuring the appropriate curves and form for Balinese dance. However, repetitive movements over long periods also contribute to musculoskeletal complaints.[4,18] High training frequency is associated with increased symptoms of overtraining, which in turn raises the risk of injury. Therefore, training frequency's indirect effect on injury is mediated by overtraining symptoms.[37] In this context, it is crucial to consider how high training frequency affects posture. The more frequently an individual maintains an incorrect posture, the greater the risk of musculoskeletal disorders. Repetitive non-ergonomic postures with excessive inclination angles can strain muscles, tendons, and ligaments, hinder recovery, and cause cumulative trauma due to inadequate biomechanical adaptation.[19]

The Relationship Between Dance Training Onset and the Incidence of Lumbar Hyperlordosis

Based on the bivariate analysis results using the Chi-square test (Table 6) and Phi correlation test (Table 7), a p-value < 0.001 and a correlation coefficient of 0.616 were obtained. This indicates a significant correlation between the onset of dance training and the incidence of lumbar hyperlordosis among Balinese dancers at SMKN 5 Denpasar.

These findings are consistent with research by Iunes et al. (2016), which states that a longer training duration (4-9 years) is associated with a significant increase in lumbar lordosis compared to the control group.[38] Moreover, participants with more extended dance experience demonstrated a higher risk of injury. This is due to the training beginning at a young age and continuing throughout growth with repetitive movements. Misadaptation of this posture can place excessive stress on the spine, particularly the lumbar region, leading to pain among dancers.[39]

Athletes with more excellent cumulative training hours exhibit a more pronounced sagittal spinal curvature. The longer and more frequently an individual trains, the more likely they will experience mechanical loading on the spine. This is in line with the extreme ranges of motion required during dancing, which can lead to increased lumbar lordosis.[6] Lumbar lordosis curvature increases when training time exceeds 400 hours per year.[21] Workers with more than 5 years of service and poor ergonomic posture during work may experience continuous loading on the lower back, leading to a risk of lower back pain.[40]

Considering the age of the sample in this study, which consists of adolescents, the researchers argue that most participants began their journey in dance at an early age. Early childhood is a phase when the body is actively developing, and exposure to heavy loads during training can lead to changes in the skeletal and muscular systems and hinder the development of ideal posture. Prolonged exposure to heavy loads can affect the morphology of developing bones, risking disruption of spinal structure and mechanical strength development.[20] This study indicates that the duration, frequency, and onset of dance training correlate with the incidence of lumbar hyperlordosis among Balinese dancers. While continuous training is beneficial, it can adversely affect dancers' health if not controlled due to non-ergonomic positions that burden the spine.

Additionally, dancers may experience discomfort or lower back pain due to hyperlordosis. Individuals with hyperlordosis have a 17-fold more significant chance of experiencing high-intensity pain compared to those with normal spinal curvature.[17] The William's Flexion exercises are preventive and rehabilitative measures to reduce the effects of hyperlordosis. These exercises involve pelvic tilts, knee-to-chest stretches, partial sit-ups, hip and hamstring flexor stretches, and squats, proving effective when performed three times a week for eight weeks. This method can reduce the lumbar lordosis angle, alleviate back pain, and improve posture and lumbar muscle function.[41]

This study has several limitations that need to be considered, such as manual measuring tools that may introduce subjective variations in measurement results. Additionally, some participants exhibited fear and excessive sensitivity during lumbar lordosis curve measurements, which may affect the validity of the research findings. The accuracy of responses regarding the duration of dance training cannot be guaranteed to align with the actual practices of the samples, potentially leading to bias. Furthermore, the limited sources of journals discussing similar topics pose

challenges in comparing this research with previous studies. Therefore, further exploration of various literature sources, including research from related disciplines, is necessary to strengthen the theoretical foundation and discussion in future studies.

Despite these limitations, this study demonstrates that dance training duration, frequency, and onset are related to the incidence of hyperlordosis among Balinese dancers at SMK Negeri 5 Denpasar. The clinical implications of these findings are essential for raising awareness among dancers about the health risks they face. Therefore, a more balanced training program, including core muscle strengthening and flexibility exercises, is needed to reduce biomechanical stress on the spine. Since most participants began dance training early, routine screening becomes essential in detecting postural abnormalities early. Interventions such as posture education, physiotherapy, or corrective exercises can be implemented as preventive measures against potential musculoskeletal disorders in the future.

Recommendations for future research include: 1) Conducting further studies with larger sample size and broader scope to yield more accurate results applicable to diverse populations, 2) Investigating spinal curvature measurements in specific positions, such as the "cengked" position, to understand their influence on lumbar lordosis curvature, 3) Utilizing more accurate measuring tools such as radiography (X-Ray) to obtain more detailed data on the degree of lumbar lordosis curvature, 4) Employing more objective data collection methods such as direct observation or training logs by instructors to ensure data accuracy regarding the duration of dance training and reduce bias, and 5) Including subgroup analysis, interaction, and sensitivity assessments to understand the role of each factor in the incidence of lumbar hyperlordosis and ensure consistent relationships across various groups.

Conclusion

Based on the Chi-square test, a p-value of < 0.001 was obtained. The strength of the relationship was further analyzed using the Phi correlation, yielding correlation values of 0.501 for duration, 0.527 for frequency, and 0.616 for training onset. These results indicate a significant correlation between moderate to intense training duration, frequency, and onset and the incidence of lumbar hyperlordosis among Balinese dancers at SMK Negeri 5 Denpasar. However, this study does not establish a causal relationship between these variables. The findings highlight the need for regular monitoring through routine evaluations or guidance from instructors regarding training duration, frequency, and onset to reduce the risk of lumbar hyperlordosis in Balinese dancers. Further, longitudinal studies are recommended to better understand the causal relationships between these variables. Additionally, considering biomechanical factors and daily postural habits in future research may provide a more comprehensive understanding of the contributing factors to lumbar hyperlordosis.

Acknowledgments and Other Information

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