Assessment of Spinal Alignment among Physiotherapist Students with Primary Dysmenorrhea: A Pilot Study

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ABSTRACT

Background Primary dysmenorrhea, a common gynecological condition, may be associated with spinal alignment alterations in young females.

Purpose To assess and compare spinal alignment parameters among physiotherapist students with different primary dysmenorrhea severity.

Subjects and Methods Thirty female undergraduate physiotherapy students with dysmenorrhea from Delta University for Science and Technology were recruited and assigned to three groups (mild, moderate, and severe groups), based on the WaLIDD scale scores. Spinal alignment parameters, including thoracic curvature angle, lumbar curvature angle, sacral/hip angle, and trunk inclination angle, were measured from the sagittal plane in upright position, maximum flexion position (MFP), and maximum extension position (MEP) using the spinal mouse device.

Results Thoracic and lumbar curvature angles did not differ significantly among the three groups across all positions ($p>0.05$). However, the sacral/hip angle differed significantly between the mild and severe groups during the MFP ($p<0.05$), and the trunk inclination angle differed significantly between the mild and severe groups in both the MFP and MEP ($p<0.05$).

Conclusion Dysmenorrhea severity did not generally affect thoracic and lumbar curvature angles. However, significant differences were observed between the mild and severe groups concerning the sacral/hip angle during the MFP measurements, and the trunk inclination angle in both the MFP and MEP measurements.

Key Words: Primary dysmenorrhea; spinal alignment; spinal mouse; physiotherapy students

INTRODUCTION

Primary dysmenorrhea is defined as painful uterine cramps that occur during menstruation, representing a primary cause of pelvic pain and menstrual disorders (Kumar & Elavarasi, 2016). Its prevalence is remarkably high, affecting 45% to 93% of women in their fertile years (Vincenzo et al., 2015), with adolescent females most frequently affected (Lindh et al., 2012). Dysmenorrhea substantially impacts quality of life, including restrictions on daily activities, impaired academic performance, suboptimal sleep quality and unfavorable impacts on mood, leading to anxiety and depression (Bernardi et al., 2017).

While various risk factors have been associated with dysmenorrhea severity, such as early menarche, heavy periods, tobacco use, familial history, high body mass, alcohol consumption, depression, and stress (Coelho et al., 2014; Ju et al., 2014), emerging evidence suggests a potential link between dysmenorrhea and musculoskeletal factors. Previous studies have discovered a relationship between dysmenorrhea and lumbopelvic alignment (Kim et al., 2016a; Kim et al., 2016b).

Spinal misalignment can result in changes in the lumbopelvic region in the sagittal plane, leading to a positional change of the uterus within the pelvic cavity. It is hypothesized that dysmenorrhea may be exacerbated by increased tension in the soft tissues, including ligaments, tendons, and muscles, resulting from the anterior or posterior displacement of the uterus (Kim et al., 2016a). This hypothesis aligns with the assertion made by Genders, who proposed that dysmenorrhea could be reduced by correcting the movement of the lumbopelvic and sacroiliac joints and relaxing the surrounding muscles (Genders et al., 2003). Additionally, abnormal restriction of movement in the lumbosacral vertebrae, increased fluid accumulation within the pelvis, and uterine contractions can intensify menstrual pain. Similarly, women with pelvic imbalances tend to experience greater discomfort during menstruation, potentially due to the altered position of the uterus triggering excessive prostaglandin secretion. Notably, when the spinal alignment of women suffering from severe menstrual pain was corrected, their pain was alleviated (Kim et al., 2016b).

While previous studies have established a potential link between dysmenorrhea and spinal/lumbopelvic misalignment (Kim et al., 2016a; Kim et al., 2016b), there is a lack of research specifically examining spinal alignment parameters across different severities of primary dysmenorrhea. Understanding how spinal alignment may vary with dysmenorrhea severity could provide valuable insights into the musculoskeletal factors contributing to this condition and inform potential therapeutic interventions.

MATERIALS AND METHODS

Design

This observational cross-sectional pilot study received approval from the institutional review board at the Faculty of Physical Therapy, Cairo University, and adhered to the ethical standards outlined in the Declaration of Helsinki for human research.

Recruitment

Thirty female students diagnosed with primary dysmenorrhea were recruited from the Faculty of Physical Therapy at Delta University for Science and Technology in Gamasa, Egypt, using advertising. Participants were stratified into three groups based on dysmenorrhea severity: Mild, Moderate, and Severe groups.

The inclusion and exclusion criteria

To be included in the study, all females were virginal and non-smokers. Their age ranged from 18 to 23 years and their body mass index (BMI) ranged from 18 to 25 kg/m^2. They had regular menstruation (3-8 days in duration, with 21-34 days in-between). The participants were excluded if they had a history of pelvic pathology, any gynecological disease, history of musculoskeletal or neurological disorders, history of operations or injuries to the spine or pelvis, cancer, injured, broken, wounded or irritated skin in the back area, or a history of any stressful event in the last 6 months like parental separation or death of a first-degree relative. Also, they didn't use analgesics or non-steroidal anti-inflammatory drugs during the study period.

Group classification

Dysmenorrhea severity was evaluated using the WaLIDD scale, which focuses on Working ability, Location of pain, Intensity of pain, and Days of pain. This scale includes four metrics: Working ability, with scores ranging from 0 (never) to 3 (always); Location, scored from 0 (none) to 3 (4 locations); Intensity, also scored from 0 (never) to 3 (always); and Days of Pain, from 0 (none) to 3 (more than 5 days). The total score ranges from 0 to 12 points. Participants were assigned to mild (n=10, WaLIDD score 1-4), moderate (n=10, WaLIDD score 5-7), and severe (n=10, WaLIDD score 8-12) dysmenorrhea groups based on their score on the validated WaLIDD scale (Teherán et al., 2018).

Outcome measures

Measurement of spinal alignment parameters

Spinal alignment parameters for each participant across the three groups were measured from the sagittal plane using the Spinal Mouse® (Idiag AG, Fehraltorf, Switzerland, SN: 200217-2480). This handheld, computer-assisted electromechanical device measures spinal curvature via two rolling wheels. It captures the spinal contour and transmits the data to a computer via Bluetooth, facilitating the evaluation of spinal shape (Dreischarf et al., 2022). All spinal mouse measurements were performed by the same physiotherapist and under the same environmental conditions to improve reproducibility. The spinal alignment parameters included thoracic curvature angle, lumbar curvature angle, sacral/hip angle, and trunk inclination angle from upright position, MFP, and MEP. For upright position measurement, the participant stood relaxed with her head facing forward, gaze directed at a marker placed at eye height, feet apart at shoulder width, knees extended, and arms resting at her side. In the MFP, the participant, keeping her legs straight, was instructed to slowly bend the trunk as much as possible, attempting to touch her head to her knees and clasping her hands behind the lower legs for added stability. For the MEP, with legs kept straight, the participant was directed to cross her arms over her chest and arch the trunk backwards as far as feasible, while maintaining the head in a neutral position. The examiner initially explained and demonstrated these positions, which were then practiced once by the participant without any prior warm-up. The C7 spinous process and the anal crease top (around S3) were marked. The Spinal Mouse device was positioned at C7 and manually moved down the spine's midline to the anal crease top to measure the spinal alignment. The two wheels of the Spinal Mouse remained in contact with the skin, moving steadily and slowly along the spinal midline. Measurements were taken three times in each posture, with 1 to 2 minutes intervals between sets. The sagittal curvature in each of the three positions was determined using the Spinal Mouse's software. The thoracic curvature was assessed from T1 to T12, lumbar curvature from L1 to S1, and the trunk inclination angle was calculated based on the angle between the vertical line and a line connecting C7 to the sacrum (Roghani, et al., 2017).

Statistical analysis

Data were examined for assumptions of normality and homogeneity of variance. The Shapiro-Wilk test, which was utilized to assess normality, indicated that the data were normally distributed ($P>0.05$) following the removal of outliers identified through box and whisker plots. Furthermore, Levene's test for homogeneity of variance showed no significant differences ($P>0.05$). Consequently, the data were considered normally distributed, and parametric analyses were conducted. Statistical analysis was performed using the SPSS software, version 25 for Windows (SPSS, Inc., Chicago, IL). Numerical data are expressed as mean and standard deviation for participants' demographic data, thoracic curvature angle, lumbar curvature angle, sacral/hip angle, and trunk inclination angle from sagittal upright, MFP, and MEP. One-way analysis of variance (ANOVA-test) used to compare among mild, moderate, and severe groups for patient's female demographic data, sagittal stand, flexion, and extension measurements. Tukey's honestly significant difference (HSD) was used to compare between pairwise groups for thoracic curvature angle, lumbar curvature angle, sacral/hip angle, and trunk inclination angle from sagittal upright, MFP, and MEP. All statistical analyses were significant at probability ($p \leq 0.05$).

RESULTS

Participant Characteristics

A total of 30 females with dysmenorrhea participated in this pilot study, with 10 assigned to each of the mild, moderate, and severe groups. There were no significant differences in age, weight, height, or BMI between the groups ($P>0.05$). However, there was a significant difference in WaLIDD score among the groups ($p<0.05$) (Table 1).

Upright Position Measurements

The statistical analysis of upright position measurements revealed no significant differences between the mild, moderate, and severe groups in thoracic curvature angle, lumbar curvature angle, sacral/hip angle, and trunk inclination angle ($p>0.05$) (Table 2). Pairwise post-hoc tests also showed no significant differences between the mild vs. moderate, moderate vs. severe, and mild vs. severe groups for these measurements ($p>0.05$) (Table 3).

MFP Measurements

Statistical analysis of MFP measurements showed no significant differences between the groups in thoracic and lumbar curvature angles ($p>0.05$). However, there were significant differences in sacral/hip angle and trunk inclination angle ($p<0.05$) (Table 2). Pairwise comparisons revealed no significant differences between the mild vs. moderate and moderate vs. severe groups. However, there were significant differences in sacral/hip angle and trunk inclination angle between the mild and severe groups ($p<0.05$) (Table 3).

MEP Measurements

For MEP measurements, the analysis found no significant differences between the groups in thoracic curvature angle, lumbar curvature angle, and sacral/hip angle (p>0.05). However, there was a significant difference in trunk inclination angle (p<0.05) (Table 2). Pairwise comparisons showed no significant differences between the mild vs. moderate and moderate vs. severe groups. However, there was a significant difference in trunk inclination angle between the mild and severe groups (p<0.05) (Table 3).

Table 1. Clinical general characteristics of dysmenorrhea females among groups

Items	Groups (Mean ±SD)			*P*-value
	Mild (n=10)	Moderate (n=10)	Severe (n=10)	
Age (year)	20.60 ± 0.52	20.30 ± 0.67	20.00 ± 0.47	0.075
Weight (kg)	58.60 ± 3.56	63.30 ± 7.76	60.10 ± 7.23	0.269
Height (cm)	164.00 ± 3.02	163.50 ± 5.89	163.90 ± 6.04	0.974
BMI (kg/m^2)	21.78 ± 1.11	23.59 ±1.78	22.34 ± 2.01	0.064
WaLIDD score	2.90 ± 0.74	6.20 ± 0.79	8.80 ± 0.79	0.0001*

Data are expressed as mean ±standard deviation

P-value: probability value *Significant (P<0.05) P-value > 0.05: non-significant

Table 2. Comparison among groups for thoracic curvature angle, lumbar curvature angle, sacral/hip angle, and trunk inclination angle from sagittal upright, MFP, and MEP.

Variables	Items	Groups (Mean ±SD)			*P*-value
		Mild (n=10)	Moderate (n=10)	Severe (n=10)	
Upright	Sacral/hip angle	7.60 ± 5.68	9.90 ± 11.12	7.50 ± 7.89	0.778
	Thoracic curvature angle	55.00 ± 4.52	52.10 ± 5.74	50.20 ± 3.11	0.080
	Lumbar curvature angle	-22.90 ± 11.11	-24.40 ± 14.82	-22.70 ± 8.42	0.939
	Trunk inclination angle	-0.40 ± 2.72	2.00 ± 2.71	0.50 ± 2.37	0.134
MFP	Sacral/hip angle	36.50 ± 17.71	46.30 ± 11.81	55.30 ± 11.74	0.021*
	Thoracic curvature angle	50.90 ± 10.29	52.40 ± 10.32	58.60 ± 4.35	0.135
	Lumbar curvature angle	26.60 ± 6.22	23.40 ± 9.98	27.50 ± 8.64	0.528
	Trunk inclination angle	70.80 ± 13.17	79.10 ± 13.30	91.00 ± 10.27	0.004*
MEP	Sacral/hip angle	1.10 ± 3.81	0.10 ± 24.04	10.50 ± 17.23	0.350
	Thoracic curvature angle	48.10 ± 11.61	47.20 ± 14.84	51.90 ± 11.15	0.681
	Lumbar curvature angle	-38.50 ± 6.47	-32.40 ± 20.20	-37.30 ± 12.37	0.601
	Trunk inclination angle	-22.90 ± 8.21	-17.20 ± 7.43	-9.60 ± 8.37	0.004*

Data are expressed as mean ±standard deviation

P-value: probability value *Significant (P<0.05) P-value > 0.05: non-significant

Abbreviations: MEP, maximum extension position; MFP, maximum flexion position.

Table 3. Pairwise comparisons (Tukey's HSD) for thoracic curvature angle, lumbar curvature angle, sacral/hip angle, and trunk inclination angle from sagittal upright, MFP, and MEP.

Variables	Items	*P*-value	Tukey's HSD		
			Mild *vs.* Moderate	Mild *vs.* Severe	Moderate *vs.* Severe
Upright	Sacral/hip angle	*P*-value	0.820	1.000	0.805
	Thoracic curvature angle	*P*-value	0.348	0.067	0.629
	Lumbar curvature angle	*P*-value	0.956	0.999	0.944
	Trunk inclination angle	*P*-value	0.117	0.722	0.414
MFP	Sacral/hip angle	*P*-value	0.279	0.016*	0.338
	Thoracic curvature angle	*P*-value	0.923	0.141	0.272
	Lumbar curvature angle	*P*-value	0.676	0.969	0.530
	Trunk inclination angle	*P*-value	0.304	0.003*	0.097
MEP	Sacral/hip angle	*P*-value	0.991	0.457	0.386
	Thoracic curvature angle	*P*-value	0.986	0.781	0.687
	Lumbar curvature angle	*P*-value	0.607	0.980	0.723
	Trunk inclination angle	*P*-value	0.267	0.003*	0.105

P-value: probability value * Significant ($P<0.05$) P-value > 0.05: non-significant
Abbreviations: MEP, maximum extension position; MFP, maximum flexion position.

DISCUSSION

This pilot study aimed to assess and compare spinal alignment parameters among physiotherapist students with different primary dysmenorrhea severity. The findings suggest that dysmenorrhea severity did not significantly impact thoracic and lumbar spinal curvature angles across the three groups. However, notable differences were observed in the sacral/hip angle and trunk inclination angle between the mild and severe dysmenorrhea groups, particularly during maximum flexion and extension positions.

The relationship between the pelvis and the spine is dynamic, and previous research has suggested that unstable spinal alignment may contribute to the development of pelvic torsion, which manifests more often in the menstrual pain group in contrast to the non-pain group (Kim et al., 2016b). In the current study, the significant differences observed in the sacral/hip angle in MFP and trunk inclination angle in MFP and MEP between the mild and severe dysmenorrhea groups suggest that more severe dysmenorrhea may be associated with alterations in spinal biomechanics and alignment.

The changes in spinal alignment, particularly the sacral/hip angle and trunk inclination, may have implications for the physical symptoms experienced by individuals with primary dysmenorrhea. Research has shown that the enlarged uterus just prior to menstruation can exert pressure on nearby tissues and nerve endings, leading to pain. This effect can be exacerbated by alterations in the sacral inclination and spinal curvature in the sagittal plane, which further diminish the available space for the enlarged uterus, potentially intensifying both compression and discomfort (Oladosu et al., 2018).

The increased sacral/hip angle during the MFP in females with severe primary dysmenorrhea compared to those with mild dysmenorrhea could be attributed to altered pelvic mechanics. Muscle imbalances and postural deviations can affect the structure and functioning of the pelvic organs. Poor pelvic and lower limb muscle tone may increase anterior pelvic tilt (Shermon et al., 2019), with an associated increase in the sacral/hip angle, as the sacrum moves further anterior relative to the hip joint (Lazennec et al., 2011).

The increased trunk inclination angle during the MFP and the decreased trunk inclination angle during the MEP in females with severe primary dysmenorrhea compared to those with mild dysmenorrhea could be attributed to muscular compensation strategies. As evidenced by the findings of Oladosu et al. (2018), females with dysmenorrhea may exhibit increased abdominal muscle activity preceding menstrual cramping pain. To cope with this increased cramping and associated pain, those with severe dysmenorrhea may adopt compensatory movement strategies, such as increasing total trunk inclination during the MFP. In contrast, during MEP, the abdominal muscles may be unable to relax sufficiently to allow full movement, leading to a decreased trunk inclination angle. Additionally, individuals with severe dysmenorrhea may adopt a more flexed posture during the MFP and a less extended position during the MEP as a protective behavior against pain (Olugbade et al., 2019).

Interestingly, the current study found no significant differences in thoracic and lumbar curvature angles among the three dysmenorrhea severity groups. This contrasts with some previous findings, which have suggested a relationship between the severity of menstrual pain and hyperlordosis (Lorzadeh et al., 2021). However, a study by Walicka-Cupryś et al. (2023) found that females with menstrual pain show a reduction in both lumbar lordotic and thoracic kyphotic curvatures instead of an increase in lordotic curvature.

The discrepancies in the findings regarding spinal curvature angles may be due to various factors, such as differences in study populations, measurement techniques, and the complex interplay between spinal biomechanics and the multifaceted nature of primary dysmenorrhea. Further research with larger sample sizes and comprehensive assessments of spinal alignment and mobility is warranted to better understand the relationship between dysmenorrhea severity and specific spinal parameters.

This study has some limitations. Primarily, its pilot-based design and small sample size reduce the scope for generalizing the obtained results. Furthermore, the study's focus on a specific demographic (female physiotherapy students within a narrow age and BMI range) may not represent the broader population of women suffering from dysmenorrhea. Despite these limitations, this study represents an important step in advancing the understanding of the biomechanical alterations underlying severe primary dysmenorrhea, which can guide future clinical applications and improvements in patient care.

CONCLUSION

This pilot study reveals that while primary dysmenorrhea severity does not significantly impact thoracic and lumbar spinal curvature angles among physiotherapy students, there are distinct differences in sacral/hip angle and trunk inclination angle between the mild and severe dysmenorrhea groups during maximal flexion and extension. These findings suggest that severe dysmenorrhea is associated with `specific spinal alignment and biomechanical changes, potentially influencing the physical symptoms of primary dysmenorrhea. This study provides insights into musculoskeletal factors linked to dysmenorrhea, pointing to the need for further research to develop targeted interventions.

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