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Association Between Lumbar Lordosis and Menstrual Pain Severity in Adolescent Females

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Abstract: This study aimed to investigate the correlation between lumbar lordotic angle and the severity of menstrual pain in adolescent females. A total of 210 participants aged 13-19 years (mean age = 15.76 ± 1.37 years) were recruited from public and private secondary schools in 6th October City, Giza, Egypt. Lumbar hyperlordosis was measured using a validated digital inclinometer, and menstrual pain intensity was assessed using the Visual Analogue Scale (VAS). The mean lumbar angle and VAS score were 47.3 ° ± 4.6 and 6.2 ± 1.1, respectively. Pearson correlation analysis revealed a moderate positive correlation between the lumbar angle and VAS score ($r = 0.52$, $p < 0.0001$), indicating that increased lumbar hyperlordosis is associated with a greater severity of menstrual pain. These findings support the biomechanical hypothesis that spinal posture, particularly lumbar hyperlordosis, may influence dysmenorrhea. One non-invasive method of managing adolescent female dysmenorrhea may be postural examination and modification.

Keywords: Lumbosacral Hyperlordosis・Dysmenorrhea・Adolescents・Visual Analogue Scale

INTRODUCTION

Dysmenorrhea, or menstrual pain, affects up to 80% of adolescent females and significantly impacts school attendance, physical activity, and overall quality of life [12]. While elevated prostaglandin levels are a well-established contributor to primary dysmenorrhea, emerging evidence suggests that musculoskeletal and postural factors may also influence symptom severity [3,4].

Pharmacological treatments, such as nonsteroidal anti-inflammatory drugs (NSAIDs), target prostaglandin inhibition and are commonly used for managing dysmenorrhea. However, these medications may cause side effects, including gastrointestinal discomfort and headaches, and often provide only temporary relief. Recent literature suggests that dysmenorrhea may also be linked to muscular imbalances or postural deviations, particularly in the pelvic and lower back regions [5-7].

Lumbar lordosis, a forward curvature of the lower spine, has been proposed as a biomechanical factor influencing pelvic organ positioning, intra-abdominal pressure, and neuromuscular tone [8,9]. The female pelvis, characterized by a wider inlet and greater anterior tilt, often exhibits a more pronounced lumbar hyperlordosis, which may increase mechanical strain on pelvic structures and exacerbate menstrual pain [10,11].

While some studies have explored general postural patterns of menstrual pain, many lack precise quantification of spinal curvature. Few have specifically examined the relationship between measured lumbar lordosis and menstrual pain intensity in adolescents, a population undergoing rapid physical changes and often exposed to prolonged sedentary behavior in school settings [12-15]. This developmental phase is critical, as postural habits and menstruation patterns tend to stabilize during adolescence.

This study aims to fill that gap by objectively measuring the lumbar hyperlordosis and examining its correlation with dysmenorrhea severity in adolescent females. We hypothesize that greater lumbar hyperlordosis is associated with more severe menstrual pain. By exploring this relationship, the study seeks to support the inclusion of postural assessment in non-invasive dysmenorrhea management strategies.

MATERIALS AND METHODS

Study Design and Participants: The current study was conducted in public and private secondary schools

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in 6 October City, Giza, Egypt, from September 2020 to January 2021, and employed a cross-sectional approach. The reason for selecting a cross-sectional design was to examine lumbar hyperlordosis in conjunction with menstrual discomfort every time. Although convenience sampling improved recruitment in the school setting, it may limit generalizability due to potential selection bias. Future studies should consider random sampling to enhance external validity. This approach is ideal for exploring relationships or associations rather than causations. To reach a wide range of teenage girls in a protected environment, the school-based setting was specifically chosen. Students go through a developmental stage where postural habits, along with menstruation patterns, tend to solidify. The 210-person sample size was more than enough to identify these associations. An effect size of $r = 0.52$ (Cohen's $d \approx 1.2$) was identified as requiring no more than 12 participants in a power analysis for 80% power at $á = 0.05$. The high sample size in this study, in addition to improving the accuracy of the results, increases the scope of generalizations that can be made from these findings [16]. Participants were assessed during the first and third days of their menstrual cycle, which is frequently when dysmenorrhea symptoms peak, to standardize pain reporting and minimize variability.

Inclusion and Exclusion Criteria: The participants were biologically female adolescents aged 13 to 19 years, a period marked by significant physical development, including growth in the musculoskeletal system, hormonal fluctuations that impact menstruation and its symptoms, and spine alignment. Eligible participants also had regular menstrual cycles with accompanying menstrual pain and did not report any history of pelvic disease and/or spinal surgery [17-19].

Control confounding criteria were applied, which include the usage of hormonal contraceptives that modify menstrual cycles and pain perceptions. Diagnosed cases of secondary dysmenorrhea, like endometriosis or fibroids, were ruled out to concentrate on primary dysmenorrhea [17,18]. Postural deformities not associated with lumbar curvature, such as kyphosis, scoliosis, and forward head posture, might have introduced nonbiomechanically relevant imbalances to the study [19]. Diabetes mellitus was also excluded due to its impact on peripheral sensation, muscular control, and spinal posture [20]. This study adhered to strict inclusion and exclusion criteria, which enhanced the internal validity of the results by ensuring that the observed relationships were directly attributed to variability in lumbar lordosis.

Measurements:

Lumbar Lordosis Measurement: The lumbar lordosis was measured using a validated digital inclinometer. Participants stood barefoot, with their arms relaxed to the side, their knees slightly apart and stretched, their feet aligned shoulder-width apart, and their legs straight. The inclinometer was calibrated at T12 to assess the lumbar angle at S1, demonstrating high inter-rater reliability (ICC = 0.95) [21]. Before data collection, all assessors participated in a standardized training session to guarantee measurement consistency. By having the exact examiner repeat measures for a random subset of 20 subjects within a week, intra-rater reliability was preserved. However, by comparing the outcomes of two qualified physiotherapists on the same subset, inter-rater reliability was verified. The objective examination of posture and spinal curvature is made possible by the analytical process of biomechanics. Abnormal lordosis may affect mechanical stress on the uterus and its surrounding structures, paravertebral muscular tension, and pelvic positioning [22]. The restriction of pelvic tilt and impaired uterine drainage due to hypolordotic (flattened) spine may aggravate cramping [23]. On the other end of the spectrum, hyperlordosis may compress the stomach's contents or the uterine ligaments, which may lead to additional discomfort during menstruation [24, 25].

Pain Intensity Assessment: The severity of menstrual pain was assessed using a Visual Analogue Scale (VAS). Participants marked on a 10-cm line ranging from "no pain" (0 cm) to "worst imaginable pain" (10 cm) the level of pain they experienced. The pain scores were classified as follows: moderate (4-6 cm), severe (7-10 cm), and mild (0-3 cm). It is for this reason that the approach was selected due to its ease, sensitivity, and validity in the literature [26]. Pain levels are known to peak on day 1 of the menstrual cycle due to high levels of prostaglandin [27]. All assessments were done on these days to ensure consistency and accurate reporting [28], and this set period allowed for improved comparisons between individuals and groups. To reduce bias in responses and ensure emotional safety, assessments were conducted by trained physiotherapists in private rooms. By documenting pain at its peak, the study was better able to assess the potential impact spinal curvature may have on menstrual discomfort. To determine whether specific spinal curvatures are associated with heightened discomfort, it is essential to understand the severity of the pain [29-30]. The existence of a postural relationship with pain scores implies a possible mechanical or neurophysiological component of dysmenorrhea [31].

Anthropometric Measurements: Age, weight, and height were taken. The calculation method of body mass index (BMI) traditionally employs the formula of weight in kilograms divided by height in meters squared (BMI = kg m^{-2}) [32]. These measurements were taken to account for physical attributes that may influence menstrual health and spinal curvature. More detailed information regarding each participant's physique was obtained through anthropometric measurements, which included height, weight, and body mass index (BMI). For example, increased abdominal loading due to compensatory spinal curvatures and increased lordosis associated with higher body mass indices (BMIs) results in greater lumbar lordosis [29, 31]. On the other hand, underweight individuals may have insufficient torso muscle and low stability, which can lead to inadequate core support and alternating structural misalignments due to pain perception, altered posture, and muscular imbalance. Gathering this information provides a more complete biomechanical approach to analyzing menstrual pain. To investigate whether body composition is associated with the lordotic angle and the intensity of menstrual pain, anthropometric measurements help contextualize the findings [32].

Ethical Approval and Consent: Ethical approval was restricted to the boundaries set in the guidelines of the Declaration of Helsinki. Considering the delicate nature of the age bracket and the topic of study, which is reproductive health in adolescents, ethical precision was imperative. Participant trust and juridical adherence enabled accurate reporting of consent for the pains associated with menstruation [33].

Consent Form: All participants and their legally acceptable guardians were informed about the nature of the research and provided their signed consent. The study was explained in detail, covering its objectives, methodologies, and potential risks, and clarifying that participation is entirely voluntary. Participants were assured of confidentiality, including the ability to leave at any time without facing any repercussions.

Statistical Analysis: Statistical analysis was conducted using SPSS for Windows, version 25 (SPSS, Inc., Chicago, IL). The current test involved two dependent variables. The first one was the lumbar lordosis, and the second one was the VAS. Before final analysis, the data were screened for normality assumptions and the presence of extreme scores. This exploration was conducted as a prerequisite for performing parametric calculations to analyze differences. A Pearson correlation analysis was conducted to investigate the relationships between lumbar angle and VAS score. Both the correlation coefficients (r-values) and the p-values were calculated to assess the strength and statistical significance of this relationship.

RESULTS AND DISCUSSION

As shown in Table 1, the study group consisted of 210 participants, with mean age, height, weight, and BMI values of 15.76 ± 1.37 years, 161.65 ± 1.94 cm, 56.7 ± 5.14 kg, and 21.7 ± 1.84 kg/m², respectively.

This study identified a statistically significant, moderate positive correlation between lumbar lordosis and menstrual pain severity among adolescent females. Participants with hyperlordosis exhibited notably higher pain scores, as measured by the Visual Analogue Scale, compared to those with normal or reduced curvature. These findings suggest that spinal biomechanics have a modulating effect on dysmenorrhea. A statistical analysis was conducted to examine the relationship between menstrual pain severity and lumbar lordosis in adolescent females using IBM SPSS Statistics (version 25).

A Pearson correlation analysis was conducted to investigate the relationships between lumbar lordosis and VAS score. Both the correlation coefficients (r-values) and the p-values were calculated to assess the strength and statistical significance of this relationship. The variable "lumbar lordosis "has a moderate positive correlation with the VAS score ($r = 0.52$, $p < 0.0001$). This implies that increased lumbar lordosis is associated with a greater severity of menstrual pain, supporting the biomechanical hypothesis of the study (Table 2).

Table 1: Descriptive statistics of the participants' demographic data.

Study group	Mean	±S.D.	Minimum	Maximum
Age (years)	15.76	1.37	13.00	17.00
Height (cm)	161.65	1.94	158.00	165.00
Weight (kg)	56.70	5.14	47.50	67.40
BMI (kg m^{-2})	21.70	1.84	18.50	24.90

Table 2: Correlation Between Lumbar Lordosis and VAS.

Variable Pair	Pearson's r	Interpretation	p-value
Lumbar lordosis vs. VAS Score	0.52	Moderate Positive Correlation	p<0.0001

VAS: Visual Analogue Scale

The preceding findings contradict those of Kim *et al.* (2016), which identify effects of the alignment of the lumbar pelvis, as a passive element, and the thicknesses of abdominal muscles, as active elements, on primary dysmenorrhea and show significant differences between the primary dysmenorrhea group and the normal group in lumbar-pelvic alignment and thicknesses of abdominal muscles [14]. Among the passive aspects of stability, it was found that the lordotic angle was $0.6 \pm 0.5°$, within the normal range of 33-47° [14, 32]. Mechanically, lordosis of the spine produces increased lumbar lordosis, which results in anterior pelvic tilt and extensive strain into nociceptor- and mechanoreceptor-rich areas, namely the uterosacral and broad ligaments [34]. The ligaments supporting the uterus and pelvic viscera are posited; the tension will cause the body to be more sensitive to pain [32]. Moreover, increased curvature of the spine may also alter the positions of pelvic organs, intra-abdominal pressure, and changes in nerves that control muscles, which can worsen pain symptoms [35]. One of the anatomical explanations is that the female pelvis is uniquely structured with a broader inlet and increased sacral angle [35], which may make adolescent females more vulnerable to changes in spinal alignment during hormonal fluctuations. Although hormones like relaxin affect joint mobility, this study did not assess hormonal levels, which should be addressed in future research [34, 36].

The lumbar-pelvic strain may influence surrounding fascial systems. While not directly measured in this study, this theoretical framework may warrant future biomechanical investigation [37]. This fascial continuity provides a possible explanation for the lumbar spine's involvement in menstrual pain syndromes by indicating that strain or imbalance in one area (such as the lumbar spine) may have functional effects on the pelvic and craniosacral systems [37, 38].

Amplified lordotic curvature could equally affect neuroanatomical structures such as the sacral and lumbar plexuses, which may enhance pain conduction [39]. The fundamental reasoning behind dysmenorrhea, which encompasses biomechanical constituents, is provided by the facial continuity theories from osteopathy and manual therapy and, at the same time, proposes that the distal components of the pelvic and craniosacral systems may be subjected to mechanical stress from the lumbar spine [38, 40].

Another anatomical explanation is that the sacrum serves as the posterior component of the pelvic girdle, establishing a direct connection to the L5 vertebra at the lumbosacral junction [41], as noted in the study on the integration of menstrual pain with the pelvic girdle. Also, the lumbosacral angle, typically approximated at 30 degrees, plays a crucial role in managing mechanical stress and distributing body weight [42]. The sacral angle and lumbar curvature are influenced by the broader and more circular pelvic inlet observed in females [43].

Adolescent girls may be particularly vulnerable to changes in lumbar mechanics during hormonal fluctuations, such as those that occur throughout the menstrual cycle, due to specific anatomical predispositions unique to the female pelvis [42,44]. The relaxin hormone, associated with pregnancy, facilitates the relaxation of ligaments, thereby enhancing sacroiliac joint mobility and affecting lumbar posture [44].

Menstrual discomfort is interconnected with the pelvic viscera, which includes the uterus, bladder, and rectum, all were supported by the lumbar spine and pelvis [29]. Hyperlordosis may cause anterior pelvic tilt, altering visceral positioning and increasing strain on supportive ligaments [14]. This condition exerts force on the supportive anatomy and ligaments, such as the uterosacral ligaments [38,39]. Furthermore, it affects visceral support by modifying intra-abdominal pressure [18].

These changes, both mechanical and visceral, heighten sensitivity to inflamed and nociceptive structures, which may exacerbate the perception of pain [38]. Increased lordosis is also likely to affect some other structures of the nervous system, such as the sacral and lumbar plexuses, which could amplify pain through increased neuronal excitability [37, 38].

They also argued that the multidimensional nature of menstruation discomfort is more due to emotion, hormones, and even psychosocial issues rather than the folding patterns of one's body. Findings also suggest that posture plays a role in pain; however, it is likely less influential than the primary driver of pain. In another study, she proposed a more integrated approach to managing dysmenorrhea with physical therapy, hormone level evaluation, and psychological therapy [15, 38, 45].

The evidence suggests that the lumbar position likely modifies or enhances pain perception, even though it may not be the sole reason for the discomfort during menstruation. Clinical attention should be directed to this relationship because of the anatomical and developmental peculiarities of the teenage age group. Understanding this discrepancy, the current study aims to further the postural assessment and correction hypotheses as part of the management strategies for dysmenorrhea in adolescents, as nonpharmacological approaches tend to be more popular among this age group. Early identification and intervention may prevent chronic musculoskeletal changes and adaptations, as well as pain sensitization pathways.

This association merits consideration in clinical practice given the anatomical and developmental aspects of the adolescent population. Longitudinal studies are also recommended to investigate targeted interventions and demonstrate causal relationships.

Limitation: The design of this study is cross-sectional, which restricts the ability to gauge causation. Subjective evaluation of pain through VAS did not include possible confounding variables such as hormonal measures, body movements, and psychological stress. Subsequent studies should consist of diverse populations with longitudinal frameworks, as well as implement objective measures of pain, hormonal evaluations, and systematic transitional posture examinations. Such steps may illuminate significant causal pathways and refine specific resultant interventions. Longitudinal designs, randomized sampling, and objective instruments for measuring pain, hormone levels, and changes in posture should all be employed in future studies. These enhancements may help clarify causal relationships and direct more focused actions. Explicitly state the cross-sectional nature limits causality. VAS is subjective and could be influenced by psychosocial factors

Clinical Application: This study indicates that spinal posture, especially lumbar lordosis, may be an adjustable risk factor associated with the severity of menstrual pain in adolescents. This underscores the importance of clinical attention. Early identification of postural abnormalities and their correction may reduce the severity of dysmenorrhea and prevent long-term musculoskeletal complications in adolescent females. Incorporating physiotherapists into adolescent care teams could enhance the quality of dysmenorrhea management through targeted postural intervention. Core stabilization exercises, posture correction, ergonomic training, and other dysmenorrhea management protocols can be implemented at a reasonable cost. With increasing preference of adolescents and young adults for conservative treatment options due to potential side effects of medication, physiotherapeutic methods should be utilized as first-line treatment in dysmenorrhea management. The involvement of physiotherapists, gynecologists, and educators in the adolescent's primary healthcare team fosters a more comprehensive approach to the well-being of the young adolescent patient, thereby optimizing treatment efficacy. These musculoskeletal interventions are best emphasized during mid-adolescence, when females undergo marked structural spinal changes and when there is greater susceptibility to changing certain habits. Active correction of posture at the right age may modify the likelihood of developing chronic musculoskeletal issues, thereby reducing long-term pain vulnerability.

CONCLUSION

The current study demonstrates a moderate positive correlation between the lumbar lordosis angle and the severity of menstrual pain in adolescent females, supporting the hypothesis that spinal biomechanics, particularly deviations in lumbar curvature, may play a contributory role in modulating the intensity of dysmenorrhea.

Future research should investigate longitudinal and interventional designs to determine whether correcting lumbar alignment can effectively reduce the severity of dysmenorrhea and improve quality of life in adolescent populations.

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