REVIEW ARTICLE

Risk Factors of Lumbar Lordosis and Its Association with Lower Back Pain: A Systematic Review

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ABSTRACT

Background: Low back pain (LBP) is a global health concern with significant socio-economic effects. Lumbar lordosis (LL), a curvature of the lower spine, is often implicated in LBP; however, understanding this connection requires a proper approach. Therefore, this study aimed to systematically review the scientific evidence on factors influencing the development of abnormal lordotic posture related to LBP. **Method:** This review analysed articles from ScienceDirect, PubMed, ProQuest and Google Scholar published between 2013 and 2023. This study screened articles, assessed eligibility based on the inclusion and exclusion criteria, and evaluated the risk of bias of the study using STROBE statement checklist. The data were then descriptively analysed. **Results:** Six articles were included in this systematic review. This review identified three studies that cited the nature of work and body posture, and two studies that cited gender as factors contributing to abnormal lordotic posture related to LBP. Meanwhile, another factor, age was mentioned in one study only. **Conclusion:** The nature of work and body posture, and gender can be considered possible risk factors for the development of abnormal lumbar lordotic posture and can cause LBP. Recognizing these risk factors would be beneficial in designing targeted preventive and therapeutic strategies, particularly for high-risk individuals.

INTRODUCTION

Low back pain (LBP) is one of the musculoskeletal symptoms among various populations. In Malaysia, almost 77% of nurses at the public hospitals (Ibrahim et al., 2019) and 37% of office workers at public universities experienced LBP (Damanhuri et al., 2014). LBP is a common case that refers to healthcare centers, highlights its significance as a health problem, and has emerged as a significant medical problem affecting the adult population (Edwards et al., 2018).

In the issue of LBP, changes in the alignment of the spine can compromise body mechanics, leading to stress buildup and structural issues such as disc and facet joint degeneration, resulting in discomfort (Gong et al., 2019). The geometry of lumbar lordosis (LL) has the most significant impact on force distribution in the lower spine, playing a vital role in absorbing loads during daily activities (Proskura & Sobera, 2019). Changes in the LL angle can be a contributing factor to the development of LBP and associated work-related difficulties (Ashraf et al., 2014). Lumbar lordotic posture is considered a crucial physical factor associated with an increased prevalence of LBP (Dolphens et al., 2016). Both excessive and insufficient LL can contribute to the incidence of LBP (Proskura & Sobera, 2019).

Abnormal LL is believed to contribute to LBP because it may cause an imbalance in the lumbar lordotic curve, which affects the efficiency of the muscles around the spine (Hong & Lee, 2020). Evidence shows that deviation from the neutral position of the lumbar curve may increase the risk of developing LBP (Hasegawa et al., 2018). Besides, there is a potential link indicated between anthropometric factors and LL (Bogdanović et al., 2020). Those with abnormal body weight may have difficulty maintaining a straight posture with minimal energy expenditure, making it a potential contributor to changes in LL and consequently LBP (Kwak et al., 2020). All these show that the lordotic posture associated with LBP is a complex issue influenced by various factors.

The relationship between the causes of lordotic posture remains unclear, posing persistent questions concerning LL (Castillo, 2017). In addition, factors leading to the development of abnormal LL related to LBP also remain

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inconclusive (Chun et al., 2017). Thus, the present study systematically reviewed the factors associated with the development of abnormal lordotic posture related to LBP.

MATERIALS AND METHODS

Study Design

A systematic review study was conducted to identify and summarize the factors that contribute to development of abnormal LL related to LBP. This systematic review was not pre-registered in an international prospective registry. However, it followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement as a guideline to ensure transparency and accuracy in reporting the review (Page et al. 2021).

Inclusion and Exclusion Criteria

The selection of the studies was based on the inclusion and exclusion criteria listed in the Table 1.

Table 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
• Publication within 2013-2023. • Studies written in the English language. • Studies that report on factors contributing to lordotic posture and its association with LBP. • Studies that examine lordotic posture in association with LBP. • Observational studies.	• Studies in which the participants have idiopathic LBP.

Search Strategy

Relevant studies included in this review were retrieved through comprehensive searches of online databases, such as ScienceDirect, PubMed, ProQuest and Google Scholar. The comprehensive searches were conducted up to 9 January 2024. The search utilized Boolean operators ("AND","OR", and "NOT") to combine key terms effectively and refine the search results. The keywords employed to identify pertinent articles in this study were "factor" AND "lordotic posture" OR "low back pain" OR "back pain" OR "lumbar lordosis" OR "lordosis".

Study Selection

Reviewed articles underwent screening to eliminate redundancies, duplicates and unrelated studies. Articles with titles and abstracts that aligns with the study's objective and research question, were further reviewed and filtered based on the inclusion and exclusion criteria. Based on these criteria, the entire texts of the chosen articles were also screened. All of these processes were performed by 2 independent reviewers. Figure 1 illustrates the screening procedure along with the rationale behind the exclusion of articles and the total number of articles that remained.

Data Extraction

Data extraction from selected studies involved tabulating relevant information, including author(s) and year of publication, study design, participants and inclusion criteria, outcome measures, and results of the studies. This tabulated data provides a comprehensive overview of factors influencing abnormal LL related to LBP. The data extraction was performed by the first author, while the second author conducted a second extraction to cross-check its accuracy. Then, the results were qualitatively synthesized to construct the review.

Quality Assessment

A study by Vandenbroucke et al. (2014) stated that the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement is a reliable tool for evaluating the methodological quality of observational studies in systematic reviews. It is a priceless resource for researchers because of its thorough framework, evidence-based recommendations, cross-disciplinary application, and ability to improve reporting quality. The quality of assessment utilized the STROBE statement, a checklist of 22 items (Table 2) developed by the STROBE initiative (Von Elm et al. 2014). The specific aspects of the studies that were assessed using the STROBE statement include the title and abstract, introduction, methods, results and discussion.

RESULTS

Study Selection

This systematic review retrieved articles from online databases, namely, PubMed (n = 1), ScienceDirect (n = 213), ProQuest (n = 1475) and Google Scholar (n = 18100), contributing to a total of 19789 articles. Following the initial identification, 19748 duplicate papers were meticulously removed, resulting in a subtotal of 41 articles for further screening based on titles and abstracts. Through a rigorous screening process, 26 articles were excluded with reasoning. Then, the remaining 15 articles were evaluated according to the inclusion and exclusion criteria. Ultimately, six articles aligning with the inclusion criteria were selected for final inclusion in this systematic review, while the remaining articles were excluded based on predetermined criteria. Figure 1 illustrates the study selection process.

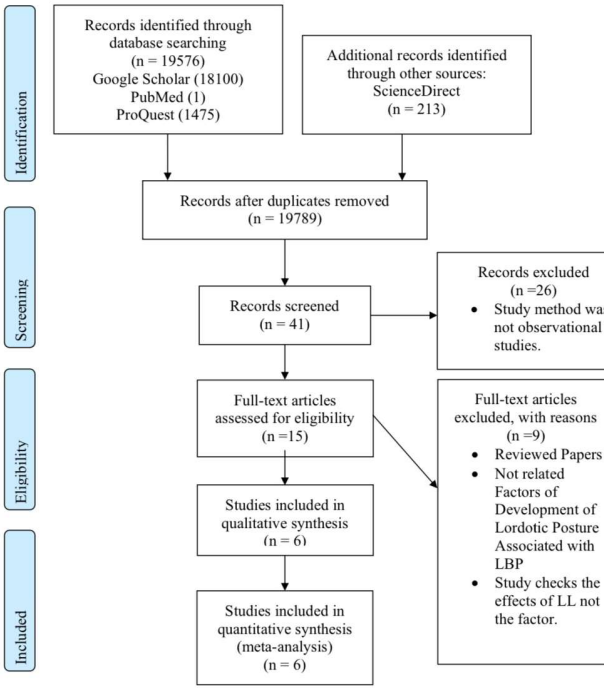

Figure 1: PRISMA flow diagram

Description of Included Studies

This study included six articles that meet the inclusion criteria, each employing distinct methodologies. Zhan et al. (2023) utilized a retrospective study design, while Pourahmadi et al. (2020) conducted a comparative observational study. The remaining four articles, namely Malarvizhi et al. (2023), Wójcik et al. (2020), Proskura & Sobera (2019) and Sorensen et al. (2015), employed a consistent cross-sectional study approach. All the included articles primarily investigate factors contributing to lordotic posture and its association with LBP. A comprehensive summary of the included studies is presented in Table 3 (appendix) for reference and clarity.

Methodological Quality

This systematic review used STROBE Statement checklist, and the result score are summarized in Table 2. The STROBE Statement checklist serves as a valuable tool to assess both the strengths and the weaknesses of the studies reported in medical literature, contributing to the overall robustness of this systematic review's findings. All the 6 papers adhere to the STROBE checklist, each 3 papers consist of 2 items not presented, and the other 3 papers consist with 4 items not reported as presented in Table 2.

Finding on Risk Factors for Lumbar Lordosis

This review found that the nature of work, body posture, gender, and age are factors contributing to abnormal LL development associated with LBP. The findings reveal that the nature of work and posture are the most possible risk factors for abnormal LL development, identified in 3 out of 6 studies. Gender was identified as a risk factor in 2 studies, and age was mentioned in 1 study. All studies showed an association between the risk factors and LBP. Only three studies indicated that the nature of work and poor posture (1 study), female gender (1 study), and age (1 study) have a positive association with LBP.

Table 2: Quality Assessment of Included Studies using STROBE Statement Checklist

Checklist	Item No.	Zhan et al. (2023)	Malarvizhi et al. (2023)	Pourahmadi et al. (2020)	Wójcik et al. (2020)	Proskura and Sobera (2019)	Sorensen et al. (2015)
Title and Abstract	1						
Introduction							
Background/Rationale	2						
Objective	3						
Methods							
Study design	4						
Setting	5						
Participants	6						
Variables	7						
Data sources/measurement	8						
Bias	9						
Study size	10						
Quantitative variables	11						
Statistical methods	12						
Result							
Participants	13						
Descriptive data	14						
Outcome measure	15						
Main results	16						
Other analyses	17						
Discussion							
Key results	18						
Limitations	19						
Interpretation	20						
Generalisability	21						
Other information							
Funding	22						

	Present
	Not present
	Not applicable

DISCUSSION

This study highlights the factors that may affect LL curvature and their relationship to LBP, including the nature of work, body posture, gender, and age.

Factors of Abnormal Lordotic Posture and Their Relationship with Low Back Pain

Nature of Work and Posture

An incidence of LL, mechanical back pain, and impairment among professional workers who spent more time standing and sitting has been reported in a study by Malarvizhi et al. (2023). The study emphasizes the detrimental consequences of prolonged standing on spinal health, highlighting a higher prevalence of back pain among professionals engaged in occupations that involve

prolong standing. In a related context, Musa et al. (2017) emphasized the adverse effects of improper body posture on musculoskeletal health, linking unnatural working postures to fatigue, discomfort, aches, and musculoskeletal illnesses. Czaprowski et al. (2018) supported this, associating improper postural elements, such as trunk lean, forward head posture, anterior pelvic tilt, postural kyphosis, and knee hyperextension, with an increased likelihood of LBP.

Besides, the degree of LL and its impact on daily activities is a critical consideration for women engaged in fitness activities. Two studies in this systematic review are particularly pertinent, as they examined how physical activity, and occupational factors affect spinal health and pain, as well as the association between LL and the LBP after prolonged sitting and standing. Prolonged sitting for more than four to six hours without movement, and prolonged standing for more than two hours without rest, have been associated with adverse effects on LL and the development of LBP (Taha et al., 2023; Mahdavi et al., 2021). This is important because it elucidates how prolonged standing or sitting affect the low back discomfort and LL curvature (Proskura & Sobera, 2019; Sorensen et al., 2015). According to Park et al. (2013), sitting posture commonly exacerbates LBP, emphasizing the challenges in adopting a neutral posture that can contribute to the development of LBP. Furthermore, the impact of spinal alignment on spinal conditions associated with LBP has been explored, highlighting that spinal posture plays the important role in the development of spinal pathology (Daffin et al., 2019). However, further research may be needed, including ergonomic assessment and evaluations of lower back symptoms, to better understand how improper posture can affect LL and cause LBP.

Gender

Two of the six research papers in this systematic review focused on factors that can contribute to lordotic posture, considered gender might be associated to LBP. Pourahmadi et al. (2020) investigated the relationship between chronic LBP and lumbar spine lordosis during sit-to-stand and stand-to-sit motions, finding a gender difference in LL and indicating that gender can influence lordotic posture in LBP. Evidence shows that men and women respond differently to seated postures (Dunk & Callaghan, 2005). Through a confluence of anatomical, physiological, hormonal, and behavioural factors, gender has a substantial impact on lordotic posture and its correlation with LBP (Wilandika et al., 2023). Changes in LL due to the stated factors can lead to discomfort and spinal instability. Gender differences in lifestyle and work-related factors can also impact LBP. For instance, women could partake in activities that involve prolong sitting or poor posture, which can worsen lordotic curvature and contribute to LBP (El-Salam and Ibrahim, 2019).

Furthermore, Wójcik et al. (2020) addressed the gender-specific elements of spinal alignment and pain experience, emphasizing the significance of LL and back pain in females over 50. This study indicated a strong correlation between an increase in LL in women and the likelihood of LBP, as women generally exhibit greater lumbar curves. Gender differences in pain, particularly in relation to LL and LBP, may be influenced by body weight. Higher BMI in women has been associated with changes in LL (Miranda et al., 2022) and affected LBP levels (Wojcik et al., 2020). As LL is believed to be influenced by individual's BMI, more research is needed to explore gender differences. This review indentified only one study that compared genders (Pourahmadi et al., 2020), while another study focused only on women (Wójcik et al., 2020), whereby both studies focused on LL related to LBP. Understanding how BMI affects LL in men and women is crucial for improving knowledge and developing gender-specific LBP prevention programs.

Age

One articles within this review delved into the influence of age on LL angles, exploring its contribution to lordotic posture and its association with LBP. The correlation between LL and LBP is particularly notable among younger patients, as shown by the strong association with LSA (Zhan et al., 2023). Furthermore, a study evaluating patterns of sagittal standing posture in children, conducted by Araújo et al. (2016), offered valuable insights into age-related differences in spinal curvatures during development. Emphasizing the significance of posture within different age groups, Hasegawa et al. (2018) indicated that poor posture increases the risk of LBP. Krautwurst et al. (2018) also found that age affects spinal conditions, contributing to LBP. As younger patients' musculoskeletal systems are generally more adaptive and flexible, which can lead to postural changes, such as increased LL, especially in people who engage in activities that promote poor posture, such heavy backpacking or prolonged sitting. According to Mirbagheri et al. (2015), increased LL can strain on the lumbar spine and cause discomfort.

Nowadays, many young people lead sedentary lifestyles, partly due to the increased use of electronics. Sitting for long periods can cause muscle tension and also reduce LL, both of which are linked to LBP. Besides, young people who are active in sports and other physical activities that

promote good core strength may help lessen these consequences. Such activities can also increase the risk of changes in LL, and pain may result from improper training techniques or overuse injuries (Tang et al., 2023). However, more research is needed to determine whether age affects the LL angle in adults and older adults, which would help raise awareness about the importance of preventing the worsening of the LL angle changes with age.

Limitations and Future research

This systematic review has several limitations. First, the scope of this review was constrained by the inclusion of only six articles, which may limit the relevance of the findings to larger populations or specific groups. Second, the inclusion of studies with diverse methodologies may pose challenges in synthesizing findings cohesively and drawing conclusive insights. Future research should include more extensive and diverse pool of studies to enhance the robustness and generalizability of systematic reviews in this domain.

CONCLUSION

This systematic review has identified nature of work, body posture, and gender as possible factors contributing to abnormal LL associated with LBP. Age can also be one of the factors, but further research is required to provide more evidence on the relationship between age, LL and LBP. This review study clarified the complex relationship between LL angles and LBP, highlighting the necessity for a comprehensive understanding of the various elements influencing lordotic posture. The findings emphasize the need to consider these factors when assessing and treating lordotic posture and LBP. A comprehensive understanding of these risk factors is crucial for formulating focused preventive and management strategies, particularly for individuals at high risk of experiencing these conditions.

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Appendix

Table 3: Characteristic of included studies

Author /Year	Study Design	Participants / Inclusion criteria	Outcome measures	Results
Zhan et al. (2023)	Retrospective study	Participants: n = 148 (Female = 79; Male = 69) Groups: 1) NLDH group = 68 patients 2) LDH group = 80 patients Inclusion criteria 1) LBP more than 3 months, with or without radiating pain in lower extremities. 2) Age 30-40. 3) No history of severe lumbar trauma and surgery. 4) No lumbar disease such as scoliosis, lumbar spondylolisthesis, and lumbar tuberculosis.	1) Plain radiographs and magnetic resonance scan - Cobb angle = To measure LL angle - Measure IVA - Fergason method = To measure LSA	LL angle and IVA in LDH group was significantly smaller than in NLDH group (P<0.001). LSA in LDH group was significantly higher than in NLDH group (P<0.001). Age 1) Young patients with LBP which have smaller LL and IVA, and higher LSA were significantly correlated with LDH (P<0.05).
Malarvizhi et al. (2023)	Cross-sectional study	Participants: n = 30 Inclusion criteria 1) Age 25-50 years. 2) Acute mechanical LBP due to occupation, prolong standing and prolong sitting workers: duration > 4-5 hours, working experience >1year in same field.	1) Pain - Numerical pain rating scale (NPRS) 2) Disability - Quebec back pain disability scale 3) LL – Flexible ruler	Nature of work and Posture 1) The changes in LL angle were identified during prolong standing and sitting posture while working. 2) LBP is prevalent in working professional who have prolonged standing postures compared to sitting postures (P<0.04).
Pourahmadi et al. (2020)	Comparative observational study	Participants: 1) CNLBP group: n=26 2) Asymptomatic group: n=26 Inclusion criteria 1) CNLBP > 3 months in the absence of underlying pathology 2) Age 18-40. 3) Patients have ability to perform STS and SIT movements without aid	1) STS and SIT movement – High-resolution cameras, a 3-dimensional motion-capture system. The LL was analysed using Qualisys Track Manager and Microsoft Excel	Decreased LL in CNLBP group during STS and SIT compared with the Asymptomatic group (P<0.05). Gender 1) Female in asymptomatic and CNLBP groups showed significant greater mean LL values compared to males during STS (P<0.05). 2) Female in asymptomatic group showed significant greater mean LL values during STS compared to males (P<0.05).

Author /Year	Study Design	Participants / Inclusion criteria	Outcome measures	Results
Wójcik et al. (2020)	Cross-sectional study	Participants: n = 227 Groups: 1) Normal lordosis (135°-140°) 2) Shallow lordosis – higher values of LL angle (hypolordosis) 3) Deepened lordosis – lower values of LL angle (hyperlordosis) Inclusion criteria 1) Women over 50 years old with experience of pain at the lumbosacral spine.	1) Pain – Visual analogue scale 2) Collect lumbar angle at different slice locations - Multi Slice Computed Tomography (MSCT) 3) Body mass index	LL angle was associated with pain sensation of the lower back in the women population of the study (P<0.05). Gender: Body weight of women 1) Hyperlordosis significantly correlates with highest BMI, but lowest pain level (P<0.05). 2) Hypolordosis significantly correlates with lower BMI, but highest pain level (P<0.05).
Proskura and Sobera (2019)	Cross-sectional study	Participants: n = 68 Inclusion criteria 1) Female: participate in fitness activities 2) 25-70 years old	1) Disability due to LBP in everyday life– Oswestry Disability Index 2) Angle of LL – Saunder's digital inclinometer	Nature of work 1) There is a difference between angular values of LL and type of worked performed (P = 0.03). - Slightly lower angular values of LL were identified among participants who performed physical activity compared to those who performed sedentary work. - Lower angular values of LL were identified among pensioners compared to those who performed sedentary and physical works. 2) LBP increases among people performing sedentary work. Posture 1) The intensity of back pain of the participants was moderately associated with level of pain during sitting (r = 0.48).
Sorensen et al. (2015)	Cross-Sectional Study	Participants: n = 57 - Female = 28, Male = 29 - PD = 24, NPD = 33 Inclusion criteria 1) No lifetime history of an episode of LBP	1) Pain – Visual Analogue Scale 2) Participants habitual physical activity – Baecke Questionnaire of Habitual Physical Activity 3) LL (prior to 2 hours standing) – Marker position (motion capture system)	Nature of work and Posture 1) LL during standing among PD participants was significantly larger compared to NPD participants (P = 0.02) 2) The curvature angle of LL during prolong standing (2 hours) has a significant relation to LBP symptom intensity (pain) (P = 0.02).

**Note. LL= Lumbar Lordosis; NLDH=Non-Lumbar Disc Herniated; LDH=Lumbar Disc Herniated; IVA=Intravertebral Angle; LSA=Lumbosacral Angle; CNLBP=Chronic Non-Specific Low Back Pain; PD=Pain Developer; NPD=Non-Pain Develop; STS=Sit to Stand; SIT=Stand to Sit