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Spinopelvic Parameters as Risk Factors of Nonspecific Low Back Pain: A Case-Control Study

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Abstract

Background: The effect of spinopelvic alignment on low back pain (LBP) incidence has been studied in many investigations. However, the interrelation between spinopelvic parameters and LBP is poorly understood. In particular, it is unknown whether particular patterns of spinopelvic parameters render nonspecific LBP. In this study, we aimed to evaluate the role of spinopelvic parameters as risk factors of nonspecific LBP.

Methods: In this case-control study, spinopelvic parameters, including lumbar lordosis (LL), sacral slope (SS), pelvic tilt (PT), and pelvic incidence (PI), were compared between 148 patients with nonspecific LBP and 148 healthy controls. Demographic characteristics of the patients, such as age, gender, occupation, smoking, diabetes mellitus, and body mass index (BMI), were recorded as confounders. Spinopelvic parameters were assessed using radiographic findings in 2 groups. The analysis was done once as univariate (Kolmogorov-Smirnov test) and once as multivariate (multivariate logistic regression) analysis.

Results: Univariate analysis showed that female gender, higher BMI, smoking, and blue-collar jobs were associated with a higher risk of nonspecific LBP. LL, SS, and PI, but not PT, were all greater in LPB patients in the univariate analysis regarding the spinopelvic parameters. Multivariate analysis showed female gender (odds ratio adjusted (ORAdj) = 4.26 [95% CI, 2.11-9.58]; $P = 0.001$) and LL (ORAdj = 1.58; [95% CI, 1.18-3.22]; $P = 0.026$) were predictable risk factors for Nonspecific LBP.

Conclusion: Spinopelvic parameters, particularly LL, could be considered as risk factors of nonspecific LBP so that a more significant LL might indicate a greater risk of LBP. However, the role of other parameters in this association could not be neglected.

Keywords: Low Back Pain, Spinopelvic Parameter, Lumbar Lordosis

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Introduction

Low back pain (LBP) is one of the most common prevalent and debilitating musculoskeletal problems worldwide, with a mean global prevalence of up to 20% (1). The underlying cause of nonspecific LBP with such symptoms as tension, pain, and/or stiffness in the lower back is still unknown. Most people have LBP at some point in their lives. One of the most frequent reasons people are admitted to hospitals and are absent from work or school is this disorder, especially in developing countries. (2) The prevalence of LBP has been reported to be 29.3% in the Iranian population. This higher prevalence was attributed to the population obesity (3). The rate of LBP increases with the continuing growth of obesity (4), which results in a growing economic and health burden of LBP (5). Therefore, developing strategies to prevent or slow down LBP incidence is critical

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↑What is "already known" in this topic:
The effect of spinopelvic alignment on the incidence of low back pain (LBP) has been studied in many investigations. However, the interrelation between spinopelvic parameters and LBP is poorly understood.

→What this article adds:
We aimed to evaluate the role of spinopelvic parameters as risk factors of nonspecific LBP for better management of the patients.

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for modern societies.

Identifying LBP risk factors is one of the most efficient approaches for the deceleration of LBP incidence through screening high-risk patients and the implication of education programs (6). There are still many unknown factors that can affect LBP. Several studies have identified some sociodemographic behaviors and factors as the cause of this disorder, such as age, female gender, smoking, inactive lifestyle, occupations requiring heavy lifting, and underlying disorders such as rheumatoid arthritis and diabetes (7-9).

Balanced sagittal spinopelvic alignment is an important component of spinal function, which is necessary to maintain an energy-efficient body posture (10). Impairment of this alignment has been reported in many spinal pathologies, such as degenerative scoliosis (11). Recently, spine anatomy, as an inherent risk factor of LBP, has attracted much attention, and the role of spinal alignment in the incidence of LBP has been pronounced. However, the findings are not conclusive regarding the role of spinal alignment in the pathogenesis of LBP (12-17).

One of the main reasons for such inconclusive results is the univariate analysis of the association between spinopelvic parameters and LBP, while LBP is acknowledged as a multifactorial disorder (17). Many epidemiological studies have examined the relationship between demographic variables and LBP (18, 19). Comprehensive research in Iran has not examined the relationship between spinopelvic parameters and nonspecific LBP. Therefore, due to the high prevalence of this disorder in Iran, the present study was designed to investigate the association between spinopelvic parameters and nonspecific LBP.

Methods

The institutional review board approved this case-control study and patients provided written consent before participation in the study. All patients with the complaint of nonspecific LBP who were referred to Rasoul Hospital orthopedic clinic Between October 2017 and October 2019 were included in the study. Sampling was performed in an accessible and consecutive among patients referred to the clinic. The case group was selected from among patients who complained of nonspecific LBP. The control group was selected from the healthy companions of the patients who were referred to the clinic. Group matching was performed to control age and sex variables. Inclusion criteria included age over 18 and under 65 years and patients who continuously complained of nonspecific LBP in the last 3 months. Exclusion criteria were patients with spinal deformities (scoliosis or spondylolisthesis), discopathy, history of spinal fracture or surgery, leg length discrepancy, degenerative changes of the spinal column, rheumatoid arthritis, and hip or lower limb deformities, and use of medications that could affect bone quality (20, 21). Finally, 148 patients were identified as eligible. A total of 148 healthy controls were included as the control group. Exclusion criteria were applied for both groups. The flowchart of the study exclusion and inclusion is demonstrated in Figure 1.

The characteristics of participants, including age, gender, body mass index (BMI), job, smoking history, and underlying disorders, such as diabetes mellitus, were recorded. The smoking amount was categorized into sometimes <10 packs per year and >10 packs per year. The participant's job was recorded as either the white-collar worker or a blue-collar worker.

There are many radiographic methods for evaluating pelvic and lumbar spine (22). An anteroposterior (AP) and a lateral spinopelvic radiograph were taken for all participants. AP radiographs were used to evaluate the presence of exclusion criteria. Pelvic incidence, lumbar lordosis, sacral slope, and pelvic tilt were measured on the lateral radiograph. Pelvic incidence was measured as the angle between the perpendicular line to the center of the sacral plate and the line connecting the center of the sacral plate with the center of the femoral heads. The angle between the tangent line on the sacral plate and the horizontal line was assessed to measure the sacral slope. Pelvic tilt was defined as the angle between the line connecting the center of the sacral plate with the center of the femoral heads and the plumb line (Figure 2). The Cobb's angle between the superior endplate of L1 and the inferior endplate of L5 was recorded as lumbar lordosis (23).

Spinopelvic parameters were assessed using radiographic

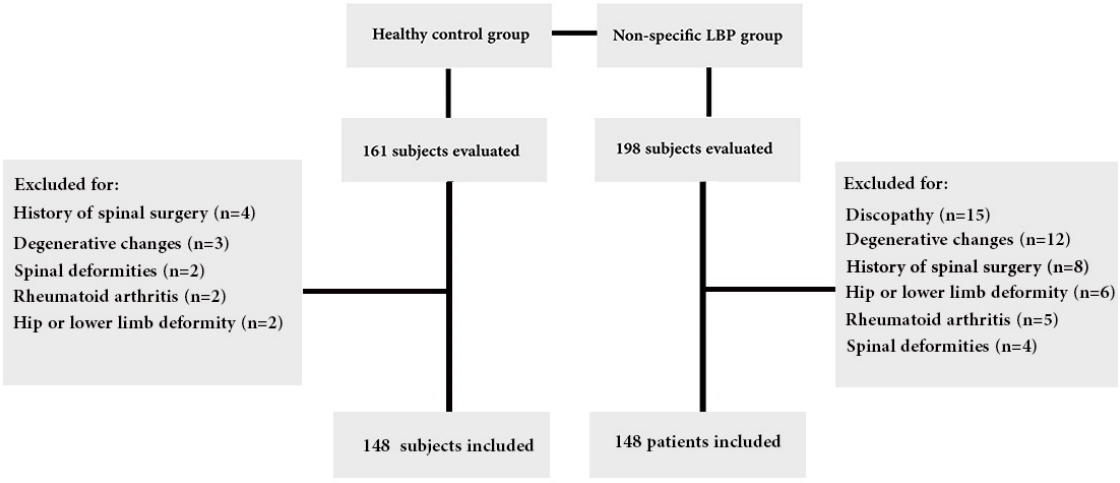

Figure 1. Flowchart of the study exclusion and inclusion citeria

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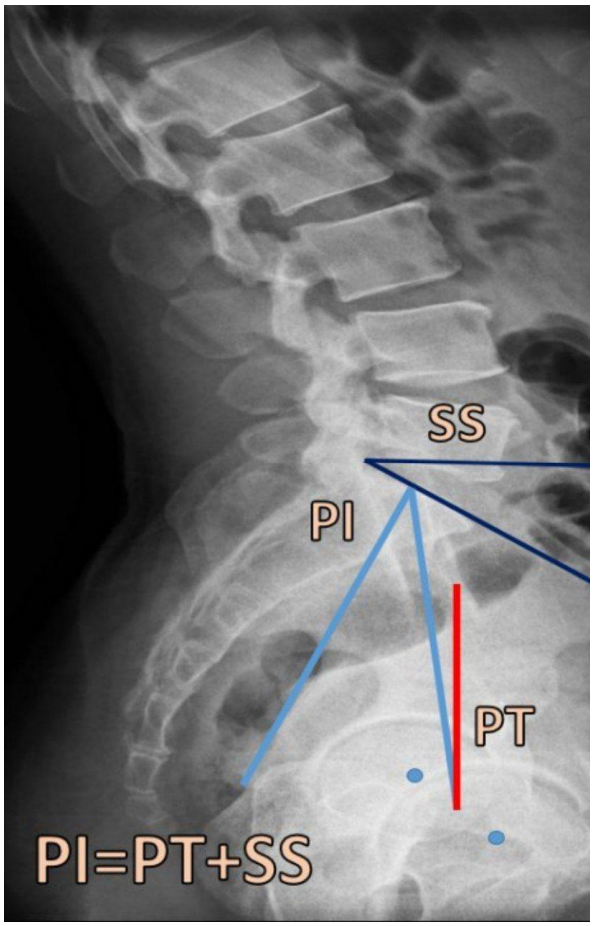

Figure 2 . Pelvic tilt measurement

findings in 2 groups. Two independent orthopedic specialists evaluated all radiographic findings. The findings of spinopelvic parameters were compared in the 2 groups.

The appropriate sample size for this study was based on the estimated effect size of 0.39 for the difference in the mean pelvic incidence in those with LBP and healthy controls based on the study by Golbakhsh et al (24), with an alpha error rate of 5%, a 95% CI at 80% power with a 1 to 1 ratio. Using G-Power software Version 3.1, a total of 131 participants were estimated for each group.

Statistical Analysis

Statistical analysis was performed using SPSS statistical software for Windows Version 16 (SPSS Inc). The chi-square test compared ordinal or nominal variables between the 2 groups. The normality of the distribution of variables was determined via the Kolmogorov-Smirnov test. For variables with normal distribution, parametric tests (independent t test) were used to compare the mean radiographic measurements between the 2 groups. For variables with non-normal distribution, nonparametric tests (U Mann-Whitney test) were used. Multivariate logistic regression analysis was used to control confounding variables. Variables with $P < 0.15$ in the univariate analysis test were entered into a multivariate logistic regression analysis using the backward selection method. The adjusted odds ratio (ORAdj) was used to report the results. Statistical significance was set at $P < 0.05$.

Results

The mean age of the participants was 35.2 ±6.5 years in the case group and 35.7 ± 7.1 years in the control group. This difference was not statistically significant ($P = 0.920$). The mean BMI of the case group was significantly more than the control group ($P = 0.012$). Sex distribution was significantly different between the case and control groups ($P = 0.010$); thus, the female gender was dominant in the LBP group. The number of smokers was significantly higher in the case group than in the control group (37 vs 20; $P = 0.023$). The number of cigarettes smoked per year was also significantly higher in the case group ($P = 0.040$). In addition, the case group included a higher percentage of blue-collar workers ($P < 0.001$). The sociodemographic characteristics of the patients of the 2 groups were compared in Table 1.

LL was significantly more prevalent in the case group (P < 0.001). SS was significantly more prevalent in the case

Table 1. Comparison of sociodemographic characteristics between the patients of case and control group

Variable	LBP Group (n = 148)	Control Group (n = 148)	*P* Value
Age (year)	35.2±6.5	35.7±7.1	0.921
Sex			
Male	42 (28.4)	68 (45.9)	0.011
Female	106 (71.6)	81 (54.8)	0.011
Smoking			
No	111(75)	128 (86.5)	0.040
Sometimes	13(8.8)	11(7.5)	0.040
<10 packs per year	12 (8.1)	6 (4)	0.040
>10 packs per year	12 (8.1)	3 (2)	0.040
Body mass index	26.9±3.9	25.7±3.5	0.012
Diabetes mellitus			
Yes	26 (17.6)	20 (13.5)	0.071
No	121 (82.4)	128 (86.5)	0.071
Job			
White-collar	68 (45.9)	116 (78.4)	<0.001
Blue-collar	80 (54.1)	32 (21.6)	<0.001

LBP, low back pain.
$P < 0.05$ is considered significant.

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Table 2. Comparison of spinopelvic parameters between the LBP patients and healthy controls

Spinopelvic Parameter	LBP Group (n = 148)	Control Group (n = 148)	*P* Value
Lumbar lordosis (°)	54.8±13.7	47.7±8.3	<0.001
Sacral slope (°)	35.9±8.6	30.8±6.5	<0.001
Pelvic tilt (°)	11.5±4.5	11.7±4	0.800
Pelvic incidence (°)	47.3±9.3	42.6±7.5	<0.001

LBP, low back pain.
$P < 0.05$ is considered significant.

Table 3. Binomial logistic regression showing the predictive value of demographic and spinopelvic parameters for low back pain

Variable	*P* value	OR_{Adj}	Lower 95% CI	Upper 95% CI
Age (Year)	0.977	1.001	0.959	1.044
Sex (Female)	<0.001*	4.26	2.11	9.58
BMI(Kg/m^3)	0.265	0.934	0.827	1.053
Smoking	0.955	1.008	0.981	1.010
Job	0.220	1.122	0.95	1.298
Diabetes mellitus	0.894	0.914	0.244	3.427
Lumbar lordosis	0.026*	1.58	1.18	3.22
Sacral slope	0.204	0.916	0.800	1.049
Pelvic incidence	0.928	1.006	0.880	1.150
Pelvic tilt	0.991	0.999	0.829	1.204

*Significant values. OR_{Adj}, odss ratio adjusted.

group. Also, PI was significantly more common in the LBP group ($P < 0.001$). No significant differences were observed between the PT of the case and control groups ($P = 0.800$) (Table 2).

A significant association was found between the pelvic tilt and the age of the patients so pelvic tilt was significantly more prevalent in participants aged >40 years ($P = 0.034$). A significant association was observed between smoking status and sacral slope as well as the pelvic incidence of the participants. In this respect, sacral slope and pelvic incidence were significantly associated with smoking ($P = 0.007$ and $P = 0.004$, respectively). LL was substantially more prevalent in blue-collar workers ($P = 0.045$). No other significant association was found between spinopelvic parameters and participants' demographic characteristics.

Multivariate analysis showed that female gender (ORAdj = 4.26 [95% CI, 2.11-9.58]; $P = 0.001$) and LL (ORAdj = 1.58 [95% CI, 1.18-3.22]; $P = 0.026$) were predictable risk factors for nonspecific LBP. No other significant association was found between LBP and either demographic or spinopelvic parameters in the multivariate analysis (Table 3).

Discussion

Although the association of spinopelvic parameters with LBP has been assessed in many studies, there is no consensus regarding the role of these parameters in the presentation of nonspecific LBP. One primary reason could be the univariate analysis of spinopelvic parameters and ignoring other LBP risk factors (17). This study evaluated the association of nonspecific LBP with spinopelvic parameters in both univariate and multivariate analysis models. The role of other risk factors of LBP was also assessed.

According to our results, LL, SS, and PI were significantly more prevalent in the LBP group than in the healthy control group in univariate analysis. Female sex, smoking, higher BMI, and blue-collar jobs were also significant risk factors for LBP in the univariate model. In multivariate analysis, LL was the only spinopelvic parameter found as a risk factor for LBP. Among demographic characteristics, sex was the only significant predictor of LBP in the multivariate model.

The association of sociodemographic factors with LBP has been investigated in many investigations. Biglarian et al evaluated the relationship between sociodemographic factors and LBP in the Iranian population (n = 25307). According to their results, higher age, female gender, marriage, obesity, low-economic index, smoking, living in a rural area, and low educational attainment were associated with increased odds of LBP (25). Chou et al evaluated the prevalence and factors associated with LBP in 24,435 Taiwanese adults. Female gender, low education, and blue-collor jobs were associated with a higher risk of LBP in another study (26). Williams et al evaluated the prevalence and risk factors of LBP in older adults in low- and middle-income countries. According to their survey, the prevalence of LBP was highest in Russia (56%) and lowest in China (22%). In the pooled multicountry analyses, female gender, low education, poor income, and multiple underlying morbidities were significantly associated with past-month back pain (27). In the present study, the female gender was the only significant predictor of LBP in both univariate and multivariate analyses.

Jackson and McManus evaluated sagittal plane alignment in standing lateral radiographs of 100 LBP patients and 100 age, sex, and size-matched controls. According to their report, total lordosis was significantly lower in the LBP group than in the control group. Thoracic kyphosis was not significantly different between the 2 study groups. A higher percentage of smokers was found in the LBP group (28). LL was significantly more prevalent in LBP patients in the present study. Also, in the present study, smoking was associated with LBP in the univariate analysis but not in the multivariate analysis.

Gautier et al retrospectively investigated the potential influence of spinal morphology on the risk of LBP. According to their analysis, LL was not significantly different between the LBP patients and those without a history of LBP (29). In contrast to the study of Gautier et al, in the present study, LL was significantly more prevalent in the LBP

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group compared with the controls.

Tsuji et al evaluated the correlation of LL with LBP in 489 Japanese patients. Also, 48% of the patients had experienced LBP within the past 3 months. According to their results, LBP was significantly more prevalent in women. LL was significantly lower in the LBP group (30). Similar to the study of Tsuji et al, the female gender was associated with LBP incidence in both univariate and multivariate analyses of the present study. In contrast to the study of Tsuji et al, in the present study, LL was significantly more prevalent in the LBP group compared with the control group.

Christie et al studied postural aberrations in 3 groups of participants, including those with chronic, acute, or no LBP. According to their report, patients with chronic LBP exhibited an increased LL compared with controls. Patients with acute LBP had an increased thoracic kyphosis compared with controls (31). We did not evaluate spinopelvic parameters in acute LBP. However, similar to the study of Christie et al, in this study, LL was significantly more prevalent in chronic nonspecific LBP patients than in the controls.

Roussoully et al classified LL into 4 types and found that patients with Type 2 LL in which the lordotic level involved more than 3 vertebrae with SS of <35° were more susceptible to developing back pain (32). Although we did not use this classification, we found a significant association between LL and LBP.

Chaléat-Valayer et al aimed to understand the relationship between sagittal alignment and LBP in prospective cohorts of 198 patients and 709 controls. The evaluated spinopelvic parameters included SS, PT, PI, LL, lumbar tilt (LT), lordotic levels, thoracic kyphosis (TK), thoracic tilt (TT), kyphotic levels, and lumbosacral joint angle (LSA). According to their results, SS, PI, LT, lordotic levels, TK, TT, and LSA were significantly different between LBP patients and controls. However, PT, LL, and kyphotic levels showed no significant differences between the 2 groups. Low SS, low LL, and small PI were more frequent in the LBP group (33). In univariate analysis of the present study, LL, SS, and PI, but not PT, were significantly more prevalent in the LBP group. However, in the multivariate analysis, only higher LL was found as a significant risk factor for LBP.

Blandin et al compared pelvic parameters, including SS, PT, and PI, between chronic LBP patients with an active disc disease (n = 13) and control patients (n = 22). Based on their results, no significant difference was found between the 2 groups regarding SS, PI, and PT (34). No association was found between the pelvic parameters and LBP incidence in the multivariate analysis of the present study. However, SS and PI in LBP patients were greater in univariate analysis.

Several other studies have also evaluated the association of spinopelvic parameters as a risk factor for LBP (35-38). Pregabalin in combination with agomelatin can be an effective drug for LBP (39).

Altogether, the results of the present study, combined with the results of earlier studies, reveal a potential association between LL and LBP. However, the direction of this association is controversial and should be investigated in future studies. The majority of investigations reveal no association between pelvic parameters and LBP incidence. The multivariate analysis in the present study revealed no such association.

The present study was not without limitations. As the study's main limitation, the role of other spinopelvic parameters such as thoracic kyphosis was not considered in this study. This study did not consider the role of some potential sociodemographic risk factors of LBP, such as marital status and income. Therefore, future studies are required to confirm the results of this study.

Conclusion

In univariate analysis of the present study, LL, SS, and PI, but not PT, were greater in LBP patients than the controls. However, in the multivariate analysis, only LL was a significant risk factor for LBP. These results suggest that the role of spinopelvic parameters as a risk factor of nonspecific LBP could be affected by several confounders. Therefore, these confounders should be considered in future analyses of the associations between spinopelvic parameters and LBP.

Abbreviation

LBP: low back pain
SS: sacral slope
PI: pelvic incidence
PT:pelvic tilt

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Authors' Contributions

Conception and design: B.M., A.Y., M.H., S.M., S.A., and H.F. Data analysis and interpretation: F.S. Data collection: M.H., S.M., S.A., and H.F. Authors participating in drafting the article or revising: M.M., M.H., S.M., H.F., A.Y., H.F., M.H., and S.M.

Availability of Data and Materials

The datasets used and analyzed during the current study are available from the corresponding author upon a reasonable request.

Ethics Approval and Consent to Participate

The ethics committee of our University approved this study. Due to the fact that no interventions were performed on patients, the condition for the confidentiality of patient information is not amoral restriction by the ethics committee.

Conflict of Interests

The authors declare that they have no competing interests.

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