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Radiographic lumbosacral angle has a low yield for diagnosing low back pain in workers 20-70 years of age

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ABSTRACT

BACKGROUND

The increasing trend of working from home (WFH) among workers may lead to prolonged sitting time, which is associated with increased complaints of low back pain (LBP). The lumbosacral angle (LSA) is one of the clinically important radiographic angles related to the curves commonly measured to evaluate the biomechanical factors linked with LBP. The purpose of this study was to determine the yield of radiographic LSA for diagnosing LBP among workers aged 20-70 years.

METHODS

An analytic cross-sectional study involving 119 participants was carried out in Trisakti University. Lumbosacral angle was measured using Ferguson's method. Data regarding LBP symptoms, sitting duration, and sitting position were collected using a questionnaire. Sensitivity and specificity was used to describe the characteristics of LSA as a screening test of LBP.

RESULTS

The subjects consisted of 66 women (55.5%) and 53 men (44.5 %). Their ages ranged from 20 to 64 years with a median age of 40.0 years. Mean LSA was 37.4 ± 7.3º, while the prevalence of LBP was 75 (63.0%). The optimal cut-off value of LSA for the prediction of LBP was 49.5% (95% CI: 0.385-0.606). The sensitivity, specificity, positive predictive value and negative predictive value of LSA in detecting LBP were 58.7%, 45.5%, 68.8%, and 43.6%.

CONCLUSIONS

The radiographic lumbosacral angle has a low yield for the diagnosis of LBP among workers aged 20-70 years. Further studies are needed to confirm our results and to test the application of this measurement.

Keywords: Work from home, low back pain, lumbosacral angle, workers

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INTRODUCTION

The implementation of large-scale social restriction in Indonesia has given rise to another problem. One of the things that many complain about is that since the introduction of working from home (WFH), the complaints of low back pain (LBP) are increasing among workers. The existence of WFH causes the boundaries and time between work and rest to be unclear.[1] Workers unconsciously are constantly sitting at work in front of a computer or laptop. The continuous sitting position, whether ergonomic or non-ergonomic, is one of the causes of the increase in LBP complaints during the pandemic, especially in the 30 to 60 year-olds. In another study, it was said that the LBP prevalence was unchanged or improved in almost 59%, while in more than 41% the LPB became worse.[2]

Low back pain is the most common musculoskeletal problem in the adult population. Low back pain is a pain syndrome that occurs in the lower back region.[3] Although the cause in 80-90% of cases of LBP is unknown or non-specific, it has been reported that workers tend to spend a lot of time working in front of a computer or laptop for hours in a sitting position without the sitting being interspersed with other physical activities, which can trigger LBP that commonly occurs in the lumbosacral region.[4,5]

To withstand heavy loads throughout the day, a good lumbosacral curvature is needed so that it can function in supporting the load. The existence of changes or abnormalities of the curvature is what gives rise to mild to severe degrees of LBP. Many methods are used to measure this curvature, one that has become the gold standard is the measurement of the lumbosacral angle (LSA) on lateral projection lumbar radiographs.[3]

The lumbosacral angle is formed by the intersection of two lines, namely a line drawn across the superior endplate of the S1 vertebra and a horizontal line.[6] Aside from other lateral lumbosacral spine mensuration such as lumbar lordosis (LL), lumbosacral disc angle (LSDA) and sacral inclination (SI), the LSA has been associated with some degree of instability and LBP, therefore knowledge of the LSA range is critical in the management of LBP.[2,7] The risk of LBP was reported to increase in LSA of more than 42 degrees.[3,7] Its value is also related to gender, where the LSA value in women is found to be greater than that of men.[8]

A previous study reported that changes in LSA may cause LBP, which may guide healthcare providers to include physicians to make decisions clinically, when examining patients with LBP.[9] Another research conducted by Keskin et al.[10] involving 131 office workers found that lumbar pain was present for less than 6 weeks for those workers who were working in a sitting position for more than 6 hours a day. In conclusion, this study revealed that prolonged sitting at work may be the risk factors for lumbar pain among office workers.

The study conducted by Cho et al.[4] also reports the effects of standing and different sitting positions but using lumbar lordosis (LL) as its parameters, with more detailed sitting positions being described. Their study revealed that sitting position may cause increased or reduced LL, thus showing that sitting in a chair with back support induced minor changes to the LL hence reducing the incidence of LBP.

Sitting posture can affect the trunk muscle activity and different muscles are predominantly stimulated, depending on the sitting posture [11] Previous studies have shown that some sitting postures and behaviours were associated with LBP. Bontrup et al.[12] reported that individuals with LBP demonstrated a trend towards more static sitting behaviours compared to non-LBP subjects. Jung et al.[13] also showed that prolonged sitting in a non-ergonomic posture could increase the risk of LBP.

Although there is no firm evidence for the presence or absence of a causal relationship between radiological findings and LBP, many studies have suggested that there should be such a relationship.[14,15] Importantly, since no biomechanical studies have investigated the

recovery of spinal biomechanics following sitting in various postures, the aim of this study was to determine the yield of radiographic LSA for diagnosis of LBP among workers aged 20-70 years.

METHODS

Research design

This cross-sectional study was conducted at Trisakti University, West Jakarta, in the period of September 2020 to February 2021.

Study subjects

This study involved 119 employees of Trisakti University who worked from home during the coronavirus disease 2019 (COVID-19) pandemic. The sample size was determined based on the following sample size Lemeshow's formula for cross-sectional studies based on a Z_{α} value of 1.96 for a 5% level of significance and 35.7% prevalence of low back pain according to Patrianingrum et al.,[16] which revealed that a minimum sample size of 89 subjects was required.

The inclusion criteria of this study were: (i) men and women aged between 20-70 years (ii) registered employees of Trisakti University (iii) willing to fill out an assessment evaluation questionnaire (iv) and willing to undergo lateral lumbosacral spine radiography. The exclusion criteria were: (i) known congenital spinal abnormalities such as spina bifida or congenital scoliosis, (ii) spinal fixation surgery in the lumbosacral region and (iii) suffering from an infectious disease/tumor/malignancy of the spine.

Data collection

A questionnaire was completed by the participants during this study; it included age, sex, body mass index (BMI), and LBP. The questionnaire also assessed the presence of LBP symptoms in the last 4 weeks and average sitting duration per day. It depicted various sitting positions and the study subject had to choose one of the most frequently used of the sitting positions (Figure 1).

Lumbosacral angle assessment

Lateral lumbosacral X-ray radiography was performed on each subject. The lumbosacral angle (LSA) was defined as the angle where the line tangential to the upper endplate of the sacral vertebra intersects the lower endplate of the fifth lumbar vertebra. The LSA was measured using the Ferguson's method.[17] The latter method is to first draw the AB line (a line parallel to the superior border of the sacrum), then draw the AC line (horizontal line to the sacrum).[3,8,9]

The lumbosacral angle of each subject was measured by experienced radiologists using computerized methods and recorded on a research sheet; then, the editing and coding process was carried out on a computer hard disk and the data cleansed electronically. After having the lumbosacral radiograph taken, each of the subjects was asked to fill the questionnaire.

Variability of sitting position

The questionnaire described various pictures of sitting positions and the research subject had to choose one of the most frequently used pictures

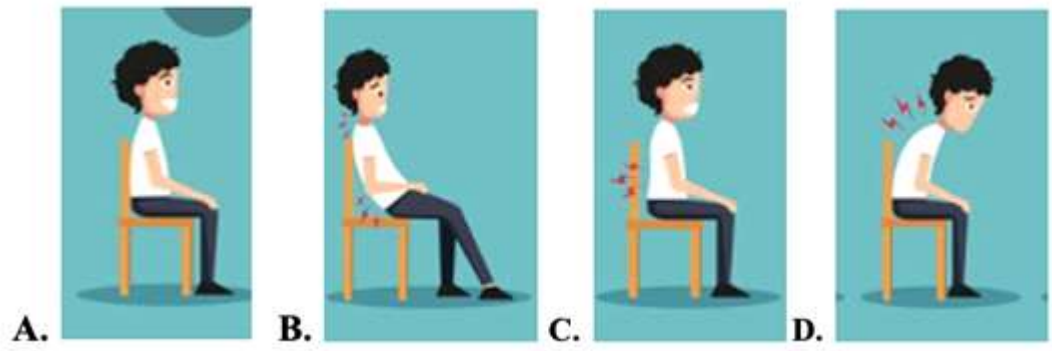

Figure 1. Various sitting positions assessed in this study

of the sitting position (Figure 1). Aside from this, the average duration of sitting during working was also asked to each subject within the questionnaire.

Statistical analysis

Data analysis was conducted using the SPSS 25 program. Since the data distribution was normal, the intergroup comparisons were performed using the one-way ANOVA test. The cut-off point of LSA in detecting LBP was measured using receiver-operating characteristic (ROC) curve analysis. Sensitivity and specificity values were used to describe the characteristics of LSA as a screening test of LBP. Statistical confidence interval (CI) was set at 95%, and p value <0.05 was considered to indicate statistical significance.

Ethical clearance

The study was approved by the Research Ethics Committee, Faculty of Medicine, Universitas Trisakti under No: 169/KER/FK/XII/2020.

RESULTS

Characteristics distribution of the study subjects

In a sample of 119 participants, there were 66 (55.5%) women and 53 men (44.5%), whose ages ranged from 20 to 64 years with a median age of 40 years, while the prevalence of LBP was 75 (63.0%) (Table 1). The median of BMI was 26 kg/m^2. The distribution of answers in the study questionnaire is shown in Table 2. From all 119 subjects, 49.6% worked from home during the pandemic, of whom 82.4% admitted that they had spent a longer time sitting than in their usual working days. The majority of the respondents admitted to sitting for an average of 3-6 hours (57.1%) without rest, while 26.1% admitted to sitting for an average of 6-9 hours per day (26.1%). In subjects with symptoms of LBP, the majority sat for > 9 hours / day (80%) and most used sitting position D (65.2%).

Table 1. Baseline characteristics of the research subjects (n=114)

Characteristic	n (%)
Age (years), (median, min-max)	40 (20–64)
Gender	
Man	53 (44.5)
Women	66 (55.5)
Body mass index, kg/m^2 (median, min-max)	26 (17.9–42.9)
Average sitting hours per day	
< 3	15 (12.6)
3-6	68 (57.1)
6-9	31 (26.1)
> 9	5 (4.2)
Sitting position	
Posture A	36 (30.3)
Posture B	15 (12.6)
Posture C	45 (37.8)
Posture D	23 (19.3)
LSA (mean± SD)	37.4 ± 7.3
LBP	
Yes	75 (63.0)
No	44 (37.0)

Data presented as n (%), except for Age and Body mass index (median, min-max) and Lumbosacral angle mean ± SD

Comparison of mean LSA between subgroups of duration and sitting position

Table 2 shows mean LSA in each average sitting duration and sitting position. According to one-way ANOVA analysis, there was no significant difference in LSA between subgroups of sitting and duration of sitting position (p=0.099 and 0.188, respectively).

Accuracy of LSA in identifying workers with LBP

In this study, we conducted ROC curve analysis to obtain the optimal cut-off point of LSA in patients with low back pain. The analysis was described in Table 3. The optimal cut-off point of LSA in this study was 37.21, with area under the curve (AUC) of 0.495 (95% CI 0.385–0.606), with sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of 58,7%, 45.5%, 68.8%, and 43.6%, respectively.

Table 2. Comparison of mean LSA between subgroups of duration and sitting position

Variable	LSA (mean ± SD)	p-value
Average sitting duration (hours)		
<3	34.3 ± 6.5	
3-6	36.9 ± 7.7	0,099
6-9	39.9 ± 6.8	
>9	31.7 ± 6.1	
Sitting position		0.188
A	38.5 ± 6.9	
B	38.5 ± 7.4	
C	35.6 ± 7.8	
D	38.6 ± 7.4	

One-way ANOVA

DISCUSSION

Our study was unable to identify a significant difference between LSA value and sitting position. With respect to LSA, prior studies have varied greatly in their results. Cho et al. [4] stated that an increase in intradiscal pressure along with flattening of the lumbar curve may result from the sitting position, thus affecting lumbosacral lordosis (LL) rather than LSA. Similarly, the study by De Baranda et al. [18] which analyzed sitting posture and its effect on sagittal spinal curvature and LBP noted that incorrect posture greatly affects sagittal spinal curvature, which might barely affect LSA. In contrast, Caglayan et. al.[9] observed that changes in LSA may cause LBP, as well as the research conducted by Melani et al.[19] which also noted a significant but negative correlation between sitting position and LBP. The discrepancy in the findings of these studies and the non-significant correlation between LSA and sitting position may be caused by many factors, including variation in sample size, variation in normal LSA cut-off values, and lack of proper education for the participants with regard to their detailed sitting position in filling out the questionnaire in the present study may contribute to variations in our results. In regard to optimal LSA cut-off value for detecting LBP (37.21º), our study is in line with the study of Jha and Ravi[3] which noted an optimal cut-off value of 32.42º for detecting LBP. The normal LSA cut-off values in the studies of Maduforo et al.[20] and Okpala [21] are 36º and 44.5º, respectively.

Our results emphasize that LSA is a poor predictor of LBP in workers. However, to our knowledge, no previous studies have assessed the diagnostic value (sensitivity and specificity) of LSA in detecting LBP. Therefore, we could not compare our results to any previous study regarding the sensitivity and specificity of LSA. We also did not observe any significant relationship between LSA and average sitting duration in this study. These findings also support the theory related to biomechanical changes. When a person sits down, the lumbosacral vertebrae carry the largest part of a person's body weight. Because the heavy load from the cervical and thoracic vertebrae is transmitted to the lumbosacral vertebrae, the longer the sitting

Table 3. Accuracy of LSA in identifying workers with LBP

Lumbosacral angle	Low back pain		Total
	Positive	Negative	
Positive	44	20	64
Negative	31	24	55
Total	75	44	119

Sensitivity = 58.7%; Specificity = 45.5%; Positive predictive value = 68.8%; Negative predictive value: 43.6%; Optimal cut-off of LSA for predicting LBP: 37.21º

duration, the harder the work of the lumbosacral vertebrae. Sitting continuously for a long period of time increases the pressure on the intervertebral discs, thereby stiffening the lumbar vertebrae and weakening the lower back muscles, which subsequently lead to changes in the position of the lumbosacral vertebrae and radiographic lumbosacral spine mensuration, including LSA. It has been reported that more static sitting position may lead to sustained pressure under the buttocks and continuous compression on the intervertebral discs, hence causing LBP.[12] However, it has been established that lumbar lordosis is decreased more in the sitting position than in the standing position. This postural change increases the load and stress on the lumbar spine and surrounding structures, hence increases the risk of low back pain. Although proper upright sitting postures involve anterior pelvic tilt, lumbar lordosis and relaxation of the thoracic spine, which reduces the pressure on the intervertebral discs, most people tend to sit in a slouched posture for prolonged time periods, which is often accompanied by an abnormal posture of the spine and pelvis. When the posture is maintained with the neck and trunk bent forward, the back extensors are over-activated, and the constant load on these muscles may increase the risk of neck and back pain.[22]

Another influencing factor is the cut-off LSA value, which varies greatly between studies. This may cause difficulties in confirming the diagnosis of LBP.[23,24] These factors need to be evaluated further and may serve as input for further research.

With regard to the fact that the prevalence of LBP was high among workers, for this matter, a multidisciplinary approach involving occupational medicine may be encouraged to educate Trisakti employees on how to sit properly and correctly while working from home. The education and counseling may include stretching in between periods of work, and other exercises such as strengthening, endurance, aerobic fitness, walking, yoga, and Pilates. All these active interventions may reduce back pain, but no evidence has been found that one form of exercise is superior to the other.[10] According to Hayden et al.[25] exercise has been reported to be effective for treatment of chronic low back pain with moderate-certainty evidence, compared to no treatment, usual care, or placebo for pain.

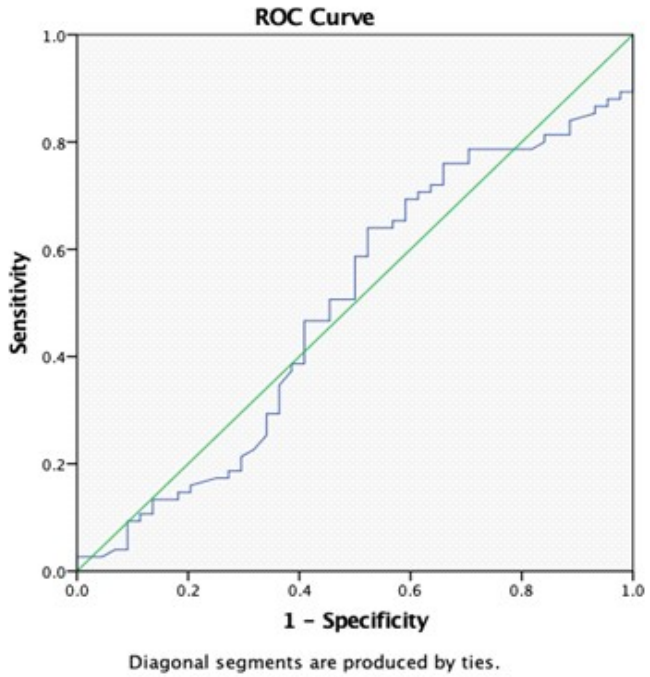

Figure 2. Receiver operating characteristics (ROC) curves for low back pain

Despite the inconsistencies in the literature and great variety in normal LSA cut-off values, several daily activities may also bring about changes in the curvatures that may come in the form of angular changes in the vertebrae affecting the value of LSA. In our process of collecting data, it was challenging to educate participants on how to correctly fill the questionnaire or provide other data about their sitting position and duration; therefore, further studies with larger populations may be warranted.

One limitation of our study is the definitions for LBP, this data was obtained from a health interview. Such data are subject to self-reporting bias and may have had an effect on the LBP prevalence.

CONCLUSION

Our study did not demonstrate that LSA showed PPV or sensitivities high enough to be effective in screening workers for LBP. Screening based on LSA would lead to many false positive and negative test results. Further studies with a larger number of subjects may be encouraged to better determine the correlation between LSA and sitting duration.

CONFLICT OF INTERESTS

There are no potential conflicts of interest with respect to the research, authorship, and/or publication of this article declared by the author(s).

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CONTRIBUTORS

All authors will take responsibility for the content of the manuscript submitted to Universa Medicina publicly. PN, MR, GN and TC contributed to the concept and design of the study and to data acquisition, analysis, and interpretation. GN and TC contributed to the critical revision of the manuscript. All authors have read and approved the final manuscript.

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