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*Original Article*

# Determining the thickness of the lower segment of the uterus and its relationship with the prediction of premature delivery in patients with symptoms of premature delivery

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**Abstract:** Background: The study aimed to assess the thickness of the lower uterine segment and its predictive relationship with preterm delivery in patients exhibiting symptoms of labor. Methods: This prospective cohort study selected 50 pregnant women with symptoms of labor pains and regular painful uterine contractions as the case group, alongside 50 pregnant women referred at gestational ages 28-37 weeks for reasons unrelated to labor symptoms as controls. Both groups underwent transvaginal ultrasound to measure the thickness of the lower uterine segment and cervical length. Participants were followed until delivery, and comparisons of these measurements were made between the case and control groups. Findings: The average thickness of the lower segment in the control group was 3.82 ± 0.64 and in the case group was 3.26 ± 0.44 cm, and the thickness of the lower segment in the case group was significantly lower ($P < 0.001$). Also, the average length of the cervix in both controls and cases was 31.04 ± 4.6 and 27.46 ± 4.8 cm, respectively, and the difference between the two groups was significant ($P < 0.001$). Conclusion: Measuring the thickness of the lower uterine segment with transabdominal ultrasound and the length of the cervix transvaginally between 24-36 weeks of pregnancy appears to be a promising predictor for identifying premature delivery.

**Keywords:** Lower segment, premature, delivery

## Introduction

Premature birth represents a significant health challenge and is a leading cause of morbidity and mortality among newborns, accounting for two-thirds of deaths within the first year of life [1]. Spontaneous premature births occur in 7-11% of pregnancies, while very early births (before 34 weeks) are seen in 3-4% of pregnancies [2].

Current research efforts are largely focused on preventing premature birth. Clinically, premature delivery is characterized by regular, painful uterine contractions (4 contractions every 20 minutes or 8 contractions in 60 minutes) with cervical dilation of less than 3 cm, a criterion observed in approximately 80% of cases [3].

The initial step in preventing premature birth is its prediction, focusing on early identification of at-risk women and implementing appropriate treatments during prenatal care. Numerous biological and biochemical factors have been explored for diagnosing and predicting spontaneous premature birth. While certain studies have demonstrated promising outcomes, it's important to note that biochemical tests can be costly, time-consuming, and may not always be cost-effective [4]. Therefore, there is ongoing research to find more practical and efficient methods to accurately identify and manage women at risk of premature delivery.

Historically, predicting preterm birth relied on clinical history, which lacked both sensitivity and specificity. Over time, research has explored various biological markers in serum, amniotic fluid, and cervical secretions that show promise in predicting preterm delivery [5, 6]. However, utilizing these markers often leads to increased hospitalization rates, heightened maternal anx-

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iety, and elevated treatment costs [7, 8]. As a result, there is a growing need for more accurate and cost-effective methods to predict and manage preterm birth risk without imposing undue burden on patients and healthcare systems.

Transabdominal ultrasound is utilized as a diagnostic tool to assess the thickness of the lower segment of the uterus, offering a reliable method for morphological evaluation and measurement of its components [9, 10]. Towards the end of pregnancy, the uterus anatomically comprises two distinguishable parts: the thicker and more muscular upper segment responsible for uterine contractions, and the thinner lower segment primarily for fetal passage and dilation [11]. Originating from the isthmus, the lower segment spans approximately 8-10 cm in length. As labor begins, the upper uterine segment thickens while the lower uterine segment thins, a physiological response facilitating childbirth.

Patients who experience labor pains do not necessarily go on to have a premature birth; in fact, less than 10% of births occur within 7 days after the onset of labor pains or before 37 weeks of gestation. This statistic highlights that while labor pains are a common symptom, they do not universally indicate imminent premature delivery [12, 13].

In patients with preterm birth, the lower uterine segment (LUS) typically becomes thinner compared to those who carry to term [14]. This thinning, measurable via ultrasound, serves as a predictive indicator for preterm labor. Monitoring LUS thickness aids in identifying at-risk pregnancies, enabling timely clinical interventions [3]. Preventative measures, such as administering corticosteroids for fetal lung maturity, can be planned accordingly. This approach helps mitigate the risk of preterm delivery effectively [13].

The study was conducted with the aim of determining the thickness of the lower uterine segment and its relationship with predicting premature delivery in patients with labor symptoms.

## Material and methods

### *Study design*

This is a prospective cohort study that was approved by the Ethical Committee of Isfahan University of Medical Sciences with code 1399.349. The target population of the study was pregnant women who referred to the mentioned centers, who were divided into two groups of women with and without symptoms of premature labor according to the reason for their referral.

### *Inclusion and exclusion criteria*

The inclusion criteria for the study encompassed pregnant women who were primigravid (first pregnancy), carrying a singleton fetus, with intact membranes, non-smokers, and no vaginal bleeding. Additionally, participants needed to be between 28 weeks and 36 weeks + 6 days of gestation and provide informed consent. Exclusion criteria comprised conditions such as polyhydramnios and oligohydramnios, prior cervical surgery, uterine anomalies, uterine fibroids, history of previous cesarean section, abnormal placental conditions (accreta, ectopic, or low-lying placenta), intrauterine growth restriction, preeclampsia, and significant fetal anomalies. These criteria ensured a homogeneous study population suitable for investigating the predictive value of specific factors related to preterm birth.

### *Sample size calculation*

The sample size required for the study was calculated using the sample size estimation formula to compare the averages and with a confidence level of 95%, the power of the test was 80%, the standard deviation of the thickness of the lower uterine segment was estimated to be 1.15 cm [11] and the minimum significant difference between the two groups which it was considered as 0.8, it was estimated that there were 32 people in each group, and in order to reduce the error, 50 people were included in the study.

### *Patient's groupings*

Referral women between 28 to 37 weeks of gestation were categorized into case and control groups based on their referral reasons. The case group consisted of women experiencing symptoms such as labor pains and regular, painful uterine contractions (defined as 4 contractions every 20 minutes or 8 contractions in 60 minutes, with cervical dilation less than 3 cm in 80% of cases). In contrast, the control

group included women referred during the same gestational age range but for reasons unrelated to labor symptoms. This grouping strategy aimed to facilitate the comparative analysis of factors associated with preterm labor.

The labor symptoms in this study included: regular or frequent contractions leading to cervical dilation, lower back pain or a feeling of pressure in the pelvis, and vaginal spotting or light bleeding. Other symptoms are a change in vaginal discharge, including an increase in volume or the presence of mucus, water, or blood, and gastrointestinal symptoms such as diarrhea.

*Ultrasound studies*

Both the case and control groups underwent abdominal ultrasound to measure the thickness of the lower uterine segment and transvaginal ultrasound to measure cervical length. Prior to the ultrasound, patients consumed 200 cc of water 30 minutes beforehand to facilitate bladder filling. They then lay in a supine position, slightly turning to the left side. The lower uterine segment was measured from the upper 2 cm of the internal os, while cervical length was measured via transvaginal ultrasound. These measurements, along with demographic and clinical data, were recorded in a structured data collection form. Follow-up continued until delivery for both groups, allowing for comparisons of lower uterine segment thickness and cervical length between cases and controls. To determine the relationship between the thickness of the lower uterine segment (LUS) and the prediction of preterm birth, a logistic regression analysis was performed. This analysis assessed the effect of LUS thickness on the likelihood of preterm delivery. By measuring LUS thickness using ultrasound and analyzing its association with preterm birth outcomes, the study identified that an increase in LUS thickness significantly decreases the chances of preterm birth.

*Statistical analysis*

Data were analyzed using SPSS software version 29. We used t-test and Chi square tests to compare data and assess nominal outcome variables between groups. We considered a the two-tailed significance test with a *p*-value of < 0.05, as a statistically significant difference between the groups.

## Results

*Study population*

In this study, 50 pregnant women without labor pains in the control group and 50 pregnant women with labor pains in the group were examined. The average age of women in the control and case groups was 26.86 ± 5.77 and 28.6 ± 6.1 years, respectively, and there was no significant difference between the two groups (P = 0.15).

*Pregnancy data*

The average length of pregnancy at the time of ultrasound in both control and case groups was 31.45 ± 2.3 and 31.73 ± 2.4 weeks, respectively, and there was no significant difference between the two groups (P = 0.54). The average weight of the fetus in the two groups was 1748.3 ± 522.4 and 1837.14 ± 900 grams, respectively, and no significant difference was seen between the two groups (P = 0.55).

*Ultrasound findings*

The average amount of fluid around the fetus in the control and case groups was 135 ± 24.08 and 127.76 ± 27 ml, respectively, and the difference between the two groups was not significant (P = 0.16). The results are shown in **Table 1**.

The mean thickness of the lower segment in the control group was 3.82 ± 0.64 and in the case group was 3.26 ± 0.44 cm, and the thickness of the lower segment in the case group was significantly lower (P < 0.001). Also, the average length of the cervix in both controls and cases was 31.04 ± 4.6 and 27.46 ± 4.8 cm, respectively, and the difference between the two groups was significant (P < 0.001).

The average ratio of the thickness of the lower segment to the length of the cervix in the control and case groups was 0.225 ± 0.022 and 0.121 ± 0.022, respectively, and the difference between the two groups was significant (P < 0.001). In **Figures 1** and **2**, the median, range and percentile of 25-75% of the thickness of the lower segment and the length of the cervix in two groups are shown.

*Further assessments*

According to the obtained results, the highest thickness of the lower segment was observed

**Table 1.** Mean and standard deviation of age, gestational age and fetal weight in two groups with case and control

| Variables | Groups | | *P*-value* |
|---|---|---|---|
| | Control | Case | |
| Mothers age (year) | 26.86 ± 5.77 | 28.6 ± 6.1 | 0.15 |
| Gestational age (week) | 31.45 ± 2.3 | 31.73 ± 2.4 | 0.54 |
| Fetal weight (gr) | 1748.3 ± 522.4 | 1837.14 ± 900 | 0.55 |
| Amount of fetal fluid | 135 ± 24.8 | 127.76 ± 27 | 0.16 |

*Independent T test.

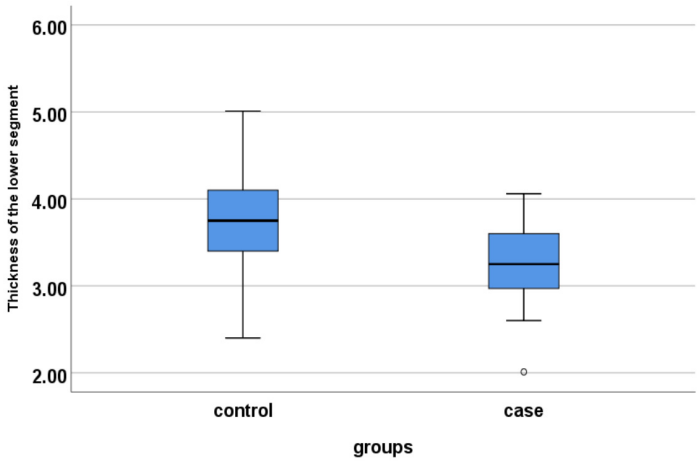


**Figure 1.** Median, range and percentile of 25-75% of lower segment thickness in two groups. There was a significant difference between the two group regarding lower segment thickness.

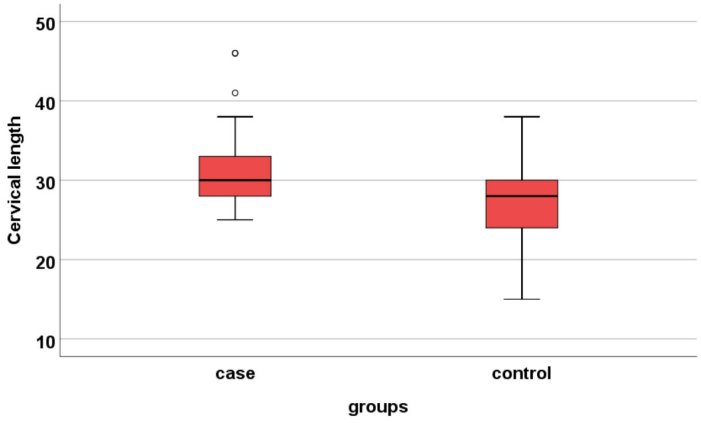


**Figure 2.** Median, range and percentile of 25-75% of cervical length in two groups. There was a significant difference between the two group regarding cervical length.

in the 28th week and the lowest thickness was observed in the 35th week of pregnancy. Also, the length of the cervix was the highest in the 29th week of pregnancy and the lowest in the 35th week, but according to the one-way analysis of variance, the thickness of the lower segment of the uterus and the length of the cervix were not significantly different according to the gestational age (P = 0.34 and P = 0.96, respectively). The results are shown in **Figures 3** and **4**.

*Logistic regression analysis*

In the logistic regression analysis using the univariate (raw) method on the collected data, lower segment thickness, cervix length, fetal weight, amount of fluid around the fetus, maternal age, and gestational age were examined as variables. Lower segment thickness emerged as a significant predictor of premature delivery, with each centimeter increase reducing the likelihood by 5.98 times (P = 0.002). Similarly, each centimeter increase in cervix length decreased the chance of premature delivery by 1.7 times, which was statistically significant (P = 0.04). In the subsequent multivariate analysis using the backward conditional method, lower segment thickness, cervix length, and the amount of fluid around the fetus were retained in the model. Notably, lower segment thickness showed an odds ratio of 5.40, indicating a significant impact on the likelihood of premature birth, while cervix length had an odds ratio of 1.6. However, the amount of fluid around the fetus did not demonstrate a significant effect on premature birth risk (**Table 2**).

According to the findings of the study, there is a direct correlation of 0.46 between the thickness of the lower segment and the length of the cervix, which was statistically significant (P < 0.001) (**Figure 5**). Rock analysis on the mentioned data showed that the most suitable cut-off points for predicting premature birth is 3.5 mm, and at this point, the thickness of the lower segment has a sensi-

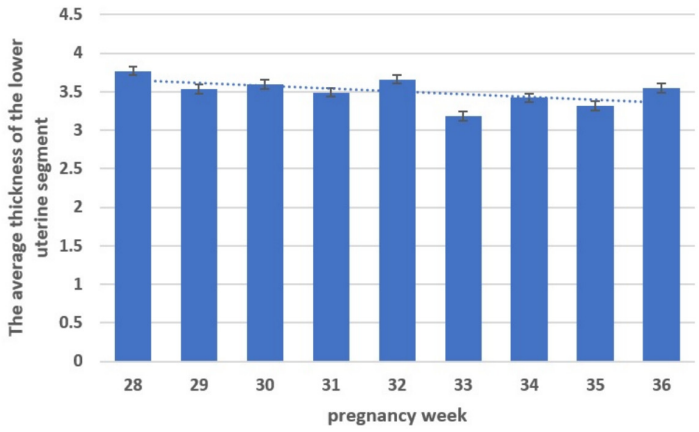


**Figure 3.** The average thickness of the lower segment according to the week of pregnancy.

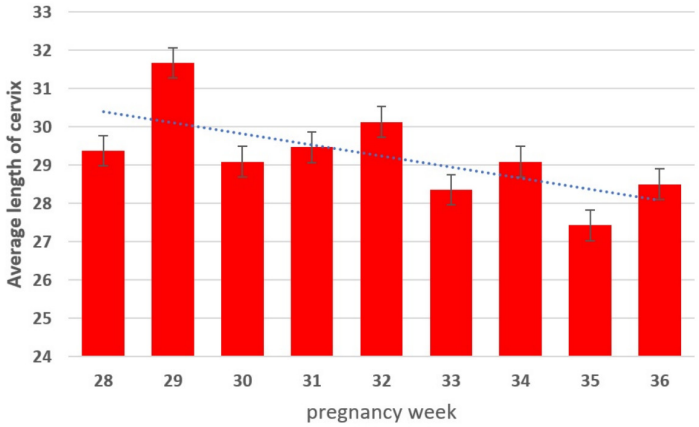


**Figure 4.** The average length of the cervix by week of pregnancy.

tivity and specificity of 72%. The area under the rock curve for the thickness of the lower segment was 0.77 and statistically significant (P > 0.001). Also, the most suitable cut-off points for cervical length to predict preterm delivery was 25 mm, at which point, cervical length had a sensitivity of 0.36 and a specificity of 0.98. The area under the rock curve for predicting preterm delivery by cervical length was 0.7 and statistically significant (P < 0.001). In **Figures 6** and **7**, the area under the rock curve for the lower segment and the length of the cervix are shown.

## Discussion

Premature birth is a distressing event that not only affects the physical and psychological well-being of the pregnant mother but also significantly increases the risks of mortality and morbidity for the baby. As a result, extensive efforts have been made to develop measures and methods to estimate the likelihood of premature birth and implement preventive strategies by providing specialized care to pregnant women at risk. Research into predicting premature birth has focused on serological methods, imaging techniques, and assessing the physical parameters of both the fetus and the mother's uterus. These approaches aim to identify early indicators and risk factors, thereby enhancing the ability to intervene effectively and mitigate the incidence of premature birth.

In the current study, several factors were identified as predictive of preterm birth. The thickness of the lower uterine segment emerged as a significant predictor, with each centimeter increase in thickness reducing the chance of preterm delivery by 5.98 times, and a cut-off point of 3.5 mm providing a sensitivity and specificity of 72%. Cervix length was another key predictor, where each centimeter increase in length decreased the chance of preterm delivery by 1.7 times, with a cut-off point of 25 mm yielding a sensitivity of 0.36 and specificity of 0.98. Although the amount of fluid around the fetus was included in the multivariate analysis, it did not significantly affect the likelihood of preterm birth. The study also found a direct correlation between lower uterine segment thickness and cervix length, indicating their combined importance in predicting preterm labor.

In their review, Ali et al. noted that fetal fibronectin measurement, when combined with cervical length assessment, could potentially aid in evaluating women experiencing acute symptoms of preterm labor, although clinical data supporting its definitive use remain limited [1]. Conversely, ultrasound serves as a non-radiative, cost-effective method for assessing the physical and anatomical coordinates of the uterus and fetus. Despite numerous studies in

**Table 2.** The results of logistic regression analysis in estimating the chance of premature delivery

| Variables | Univariate analysis | | | Multivariate analysis | | |
|---|---|---|---|---|---|---|
| | OR | 95 CI for OR | P | OR | 95 CI for OR | *P*-value* |
| The thickness of the lower dog | 5.98 | 1.93-18.6 | 0.002 | 5.40 | 1.92-15.2 | 0.001 |
| Cervix length | 1.7 | 1-2.25 | 0.04 | 1.6 | 1-1.9 | 0.041 |
| Fetal weight | 1 | 0.99-1.03 | 0.61 | Removed from model | | |
| The amount of fluid around the fetus | 1.01 | 0.99-1.03 | 0.196 | 1.02 | 0.997-1.04 | 0.11 |
| Pregnancy length | 1.07 | 0.88-1.32 | 0.49 | Removed from model | | |
| Mother's age | 1 | 0.92-1.09 | 0.99 | Removed from model | | |

*Logistic regression.

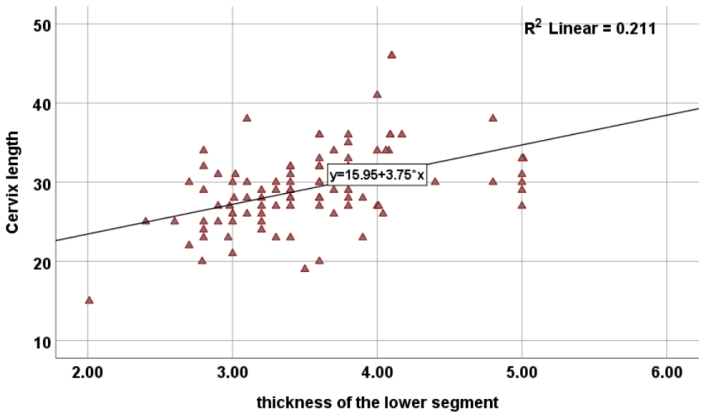


**Figure 5.** Correlation between the thickness of the lower segment and the length of the cervix.

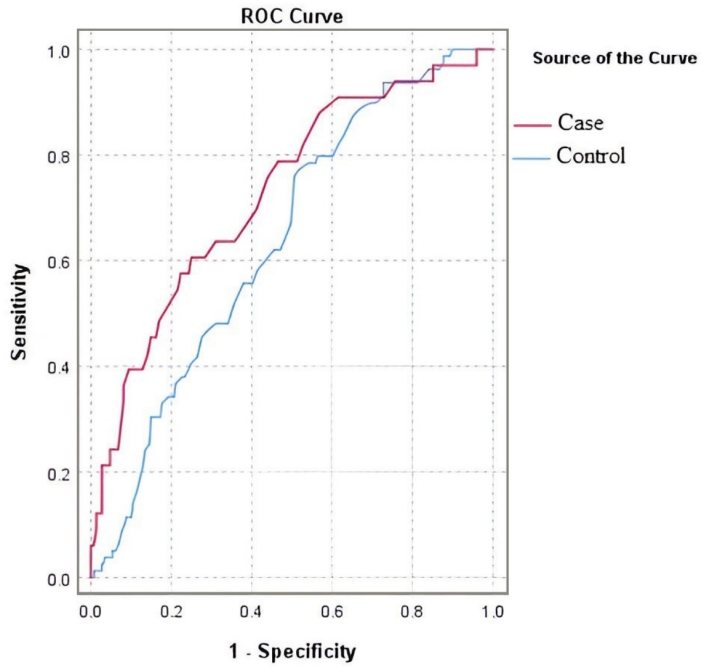


**Figure 6.** The area under the ROC curve for predicting preterm birth by the thickness of the lower segment.

this area, ultrasound lacks distinctive anatomical features specific to both mother and baby. Therefore, the current study was undertaken to investigate the relationship between lower uterine segment thickness and the prediction of premature delivery among patients presenting with symptoms of labor.

The findings of the present study showed that there was no significant difference between the two groups of control and case women in terms of basic variables such as mother's age, gestational age at the time of ultrasound, and no confounding effect of the above factors was seen in the study results.

According to the findings of the present study, women who experienced premature birth tended to have a thinner lower uterine segment. The logistic regression analysis confirmed that both lower segment thickness and cervical length significantly influenced the likelihood of premature delivery, with decreased lower segment thickness correlating with higher chances of premature birth. In a review conducted by Kok et al., which included 21 studies involving 2776 patients, the role of lower segment thickness in predicting preterm delivery was investigated. The review concluded that measuring lower segment thickness is a valuable method for predicting preterm delivery, with a thickness cutoff ranging from 0.6 to 2 mm

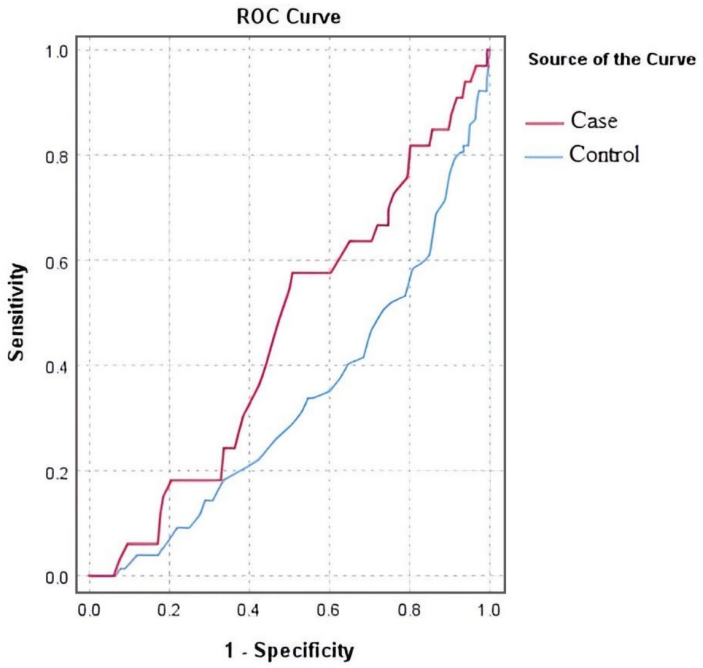


**Figure 7.** The area under the ROC curve for predicting preterm delivery by cervical length.

showing sensitivity above 75% and specificity above 92% [14].

In a study by Fukuda et al., the thickness of the lower uterine segment was measured at various stages of pregnancy, revealing a robust and significant association between lower segment thickness and the occurrence of preterm delivery [15]. Similarly, Erzincan et al. reported a significant relationship between lower uterine segment thickness and the incidence of premature birth. Their study examined changes in lower segment thickness and cervical length before and after treatment, aligning with findings from previous research [16]. These studies collectively underscore the importance of monitoring lower uterine segment thickness as a predictive factor for preterm delivery, highlighting its clinical relevance in prenatal care.

Consistent with our study's findings, Erzincan et al. observed that the average ratio of lower segment thickness to cervical length differed significantly between control and case groups. They proposed this ratio as an index for predicting preterm delivery [17, 18]. This approach aligns with our study's focus on evaluating lower uterine segment thickness as a potential predictor of premature birth, emphasizing its utility in clinical assessments and prenatal care strategies [16].

According to the findings of our study, women who experienced premature birth had significantly shorter cervical lengths, a result consistent with previous research [19]. The observed association between shorter cervical length and increased likelihood of premature delivery suggests that cervical length is a reliable predictor for identifying women at risk of preterm birth which is in line with the previous studies [20-22]. This reinforces the importance of cervical length measurement in prenatal care as a valuable tool for assessing and managing the risk of premature delivery.

The study's limitations include its reliance on prospective data collection, which restricted the ability to group participants based solely on the occurrence of preterm birth. This approach could introduce variability in predictive analyses. Additionally, the study's grouping methodology, while focused on labor symptoms versus non-labor-related referrals, may not fully capture all factors influencing preterm birth. Future research should aim to incorporate larger sample sizes and consider additional variables that could enhance the predictive accuracy of factors like lower uterine segment thickness and cervix length in identifying women at risk of preterm delivery.

## Conclusion

One key finding of the present study suggests that measuring the thickness of the lower uterine segment via transabdominal ultrasound and cervix length via transvaginal ultrasound between 24-36 weeks of pregnancy may serve as effective predictors for identifying premature delivery. However, due to limitations such as the small sample size in this study, further research is recommended in this area. Conducting more robust studies could provide additional clarity and validation regarding the predictive value of these measurements in assessing the risk of preterm birth.

## Disclosure of conflict of interest

None.

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