

Breathing Movements of Fetus, Length of Cervix and Vaginal Secretion Positive Fibronectin, As Tools to Predict Chances of Preterm Labour

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ABSTRACT

Background: The leading cause of newborn health problems and death results from preterm labour. Early predictions about developing preterm labour need to be exact to enable prompt medical assistance. This study evaluates fetal breathing movements together with cervical length measurements and vaginal fibronectin tests to determine their accuracy in predicting preterm labour whether used separately or in combination.

Methods: This was cross sectional study took place within a Lady Willingdon Hospital with n=110 pregnant women participating who were at gestational weeks 24 to 34. Three tests were utilized to evaluate fetal breathing movements and cervical length measurements using transvaginal ultrasound while fibronectin levels required vaginal secretion analysis. The study measured either preterm labour or term delivery as its primary outcome. The analysis used Sensitivity, Specificity, Predictive Values and Logistic Regression techniques.

Results: The occurrence of preterm labour developed in 50% (55/110) of all participants. Fetal breathing movements measured at 5.3 ± 1.1 movements were lower than the 7.2 ± 0.9 movements seen in control subjects with a statistically significant difference ($p < 0.05$). Preterm women exhibited cervical lengths measuring 2.1 ± 0.6 cm that were significantly shorter than the term-group values of 3.4 ± 0.5 cm ($p < 0.01$). The group of preterm subjects showed higher fibronectin concentrations than term subjects along with measurements of 50.2 ± 20.5 ng/mL versus 10.1 ± 8.4 ng/mL ($p < 0.01$). Multi-parameter assessment generated the most accurate results through a combined logistic model providing an odds ratio of 0.38 (95% CI 0.22–0.64, $p < 0.001$).

Conclusion: The assessment of fetal breathing movements plus cervical length along with fibronectin levels works effectively as preterm labour risk predictors. Prediction accuracy increases when different clinical parameters are combined into a single assessment approach for potential clinical implementation.

Keywords:

Gestational age, Preterm Labor, Cervical length, Assessment.

INTRODUCTION

Preterm labour represents a substantial obstetrical problem worldwide because it starts when regular uterine contractions lead to cervical changes before 37 weeks of pregnancy completion^{1,2}. The condition affects newborns critically through significant health complications which cause severe birth defects including respiratory distress

syndrome and developmental delays along with higher medical expenses³. Modern obstetric services have brought significant improvements yet healthcare providers face ongoing obstacles when attempting to foretell women who develop preterm labour because this leads to reduced intervention timing for enhanced perinatal success^{4,5}. A number of clinical, ultrasonographic and biochemical markers serve to determine the possibility of preterm delivery⁶. Previous research has shown that three predictors possess the ability to forecast preterm labour including fetal breathing movements from the biophysical profile and transvaginal ultrasound-based cervical length assessment along with fibronectin detection in vaginal fluids^{7,8}. The extent of fetal breathing movements helps evaluate both fetal health and brain development while decreased cervical length firmly proves to increase the chances of preterm birth⁹. Cervicovaginal secretions containing fetal fibronectin serve as a biochemical indicator of maternal-fetal interface changes which increases the risk of preterm labour¹⁰.

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Previous studies examined these parameters individually but regional and local research lacks combined assessment of their predictive value as non-invasive tools. The research lacks sufficient evidence about the performance of these markers collectively in the same population which hinders clinicians from developing reliable practical evidence-based strategies for preterm labour risk prediction.

The rationale of the study was to determine which of fetal breathing movements, cervical length and vaginal fibronectin measurements were best at predicting preterm labour occurrences. This research also aimed to determine whether a combination of these three risk markers would create more accurate predictive models which enhance clinical decision-making for preterm birth risk identification. The study's main focus is to enhance preterm labour management through accessible and reliable predictors which help physicians provide timely care to at-risk pregnant women.

METHODOLOGY

This was a cross sectional study conducted in the Department of Obstetrics and Gynaecology at Lady Willingdon Hospital, over six-month period from Jan 2020 to June 2020. Our study required a sample size estimation based on the sensitivity estimation formula for diagnostic accuracy studies: $n = Z^2 \times P(1-P) / d^2$ using 1.96 for Z (95% confidence level) and a sensitivity expectation of $P=0.85$ and the precision level as $d=0.067$. Our calculated sample size reached 110. Those eligible for the study were pregnant women between 24- and 36-weeks gestation who carried single babies without active labour symptoms and agreed to the study participation. Mothers having multiple gestations along with major fetal anomalies and medical disorders such as hypertension, diabetes and thyroid disease and a history of cervical cerclage and premature rupture of membranes (PROM) were excluded. All participants received consent before researchers submitted their demographic and obstetric information into an organized proforma. Study participants received ultrasound tests for monitoring fetal breathing movements together with cervical length measurement through transvaginal sonography (TVS). The measurement of cervical length obtained in centimetres helped determine preterm labour risk through the ≤ 2.5 cm limit. The researchers obtained vaginal samples for fibronectin detection through a rapid immunoassay test system. Positive outcomes occurred when doctors obtained testing results showing fibronectin levels equal to or greater than 50 ng/mL. The researchers tracked participant delivery dates to establish preterm delivery among subjects whose gestational period reached less than 37 completed weeks and term delivery at 37 weeks

or beyond. Researchers examined the individual predictive capabilities and joint strength of fetal breathing movements and cervical length measurement together with fibronectin testing. The analysis was performed through SPSS 23. Analysis involved calculating mean value and standard deviation for maternal age, gestational age and cervical length data points but frequencies with percentages represented the categorical variables. The comparison between preterm and term groups used independent t-tests or Mann-Whitney U tests for continuous variables while Chi-square or Fisher's Exact tests evaluated categorical variables. The researchers based their evaluations on sensitivity along with specificity combined with positive predictive value (PPV) and negative predictive value (NPV) for all testing procedures. A logistic regression model evaluated the predictive value of separate data points while receiving operating characteristic (ROC) analysis assessed diagnostic performance through area under the curve (AUC) measurements using ≥ 0.7 as the acceptable threshold. P value less than 0.05 was considered as significant. The research obtained ethical review board approval from the institution prior to initiation [IRB NUMBER 97/RC/KEMU]. All study participants gave written consent for participation while the ensured both confidentiality and voluntary aspects of the research at all times. Data was entered and analyzed in SPSS V25.

RESULTS

The majority of the study participants were found to be present with an average maternal age of 28.4 years (SD 5.3) and gestational age (week) 28 (24-34). Preterm labor risk assessment became crucial for these mothers because their assessment occurred during week 28 of gestation (The research included 110 participants in which 59% consisted of primigravida mothers alongside 41% who were multigravida mothers for balanced population representation.

All three parameters displayed meaningful statistical differences between women who delivered preterm versus those who delivered at term birth. The fetal breathing movement scores proved significantly different between preterm labour groups at 5.3 (1.1) versus term groups with 7.2 (0.9), according to statistical analysis with <0.05 p-value. Women experiencing preterm labor possessed shorter cervical measurements of 2.1 cm (0.6) although those delivering at term showed 3.4 cm (0.5) ($p<0.01$). The preterm labour group displayed considerably elevated fibronectin measurements which reached 50.2 ng/mL (20.5) while levels in the term group averaged 10.1 ng/mL (8.4) showing $p<0.01$ significance. The results in Table 1 demonstrate that preterm labour connects closely to diminished fetal breathing movements

together with short cervical length and high fibronectin readings.

Each diagnostic measure was evaluated through analysis of sensitivity combined with specificity and positive predictive value (PPV) and negative predictive value (NPV). The evaluation of fetal breathing movements indicated outstanding detection rates of women at risk of preterm labour with 90% sensitivity. The sensitivity measure for cervical length reached 85% while fibronectin levels demonstrated slightly lower sensitivity at 80% in this research context. Fibronectin levels achieved the best specificity score at 85% since they demonstrated effective identification of subjects who were free from risk. The diagnostic test accuracy of cervical length measurement reached 78% specificity and fetal breathing movements produced 70% specificity. All parameters demonstrated strong predictive abilities in negating preterm labor when negative test results were obtained as the NPV values remained between 82% and 88%. The evaluation demonstrates that each measurement contains specific advantages however no individual assessment showcases complete precision thus concurrent application improves diagnostic accuracy (Figure 1).

A logistic regression analysis examined individual and interdependent relationships between cervical length measurements and fetal breathing movements and fibronectin levels concerning preterm labor prediction. This study showed that increased cervical length functioned as a protective factor against preterm labour as it reduced the risk by 55% in each centimetre increase

(OR 0.45 95% CI: 0.30–0.70 p=0.001). The risk of preterm labor was correlated with fetal breathing movements at an OR value of 1.12 (95% CI: 1.02–1.24, p=0.02) because lower scores indicated higher risk. The study revealed that fibronectin levels associated with preterm delivery risk by showing an odds ratio of 1.05 while maintaining statistical significance with a confidence interval between 1.01 to 1.09 (p=0.04). Favourable values across all three parameters together substantially decreased preterm labour odds by 62% according to the predictive model (OR=0.38; 95% CI=0.22–0.64; p<0.001). The data indicates a multi-parameter prediction method provides better reliability outcomes shown in Table 2.

The diagnostic accuracy of preterm labor prediction through Receiver Operating Characteristic (ROC) curve evaluation included cervical length measurements and fetal breathing movements and fibronectin test results. The AUC value of cervical length reached 0.85 whereas fetal breathing movements maintained the top value of 0.90 which indicates outstanding predictive capability. The accuracy of fibronectin levels was indicated by an ROC curve AUC value of 0.84. These parameters together resulted in a prediction accuracy measurement of 0.92 through their combined performance. The evaluation tests demonstrated strong statistical significance at levels below p = 0.01 or p = 0.001 that confirmed their effectiveness for preterm birth assessment. These markers give clinicians a reliable tool for early intervention which should lead to better neonatal results as shown in Table 3 and Figure 2.

Table 1: Fetal breathing movements, cervical length, and fibronectin levels in preterm labour vs. delivered at term

Group	Fetal Breathing Movements (BPS)	Cervical Length (cm)	Fibronectin Levels (ng/mL)
Preterm Labour (n=55)	5.3 (1.1)	2.1 (0.6)	50.2 (20.5)
Term Delivery (n=55)	7.2 (0.9)	3.4 (0.5)	10.1 (8.4)
p-value	< 0.05	< 0.01	< 0.01

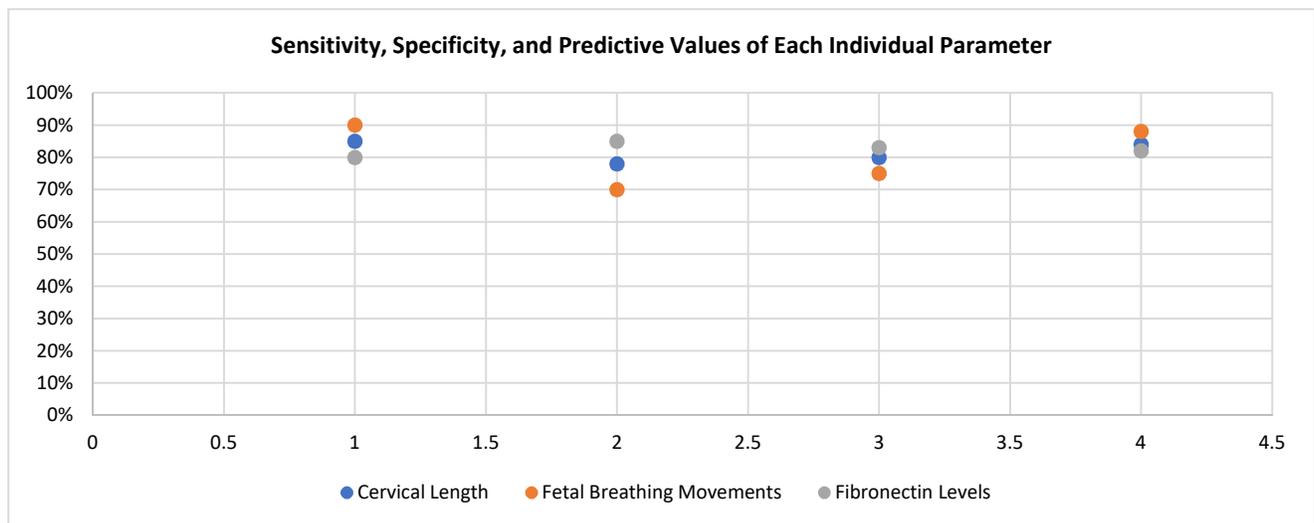


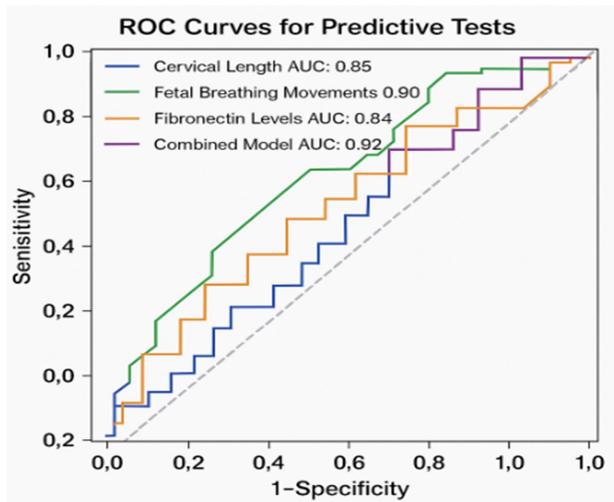
Figure 1: Sensitivity, specificity, and predictive values of each individual parameter

Table 2: Logistic regression results for combined predictive model

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Cervical Length	0.45	0.30 - 0.70	*0.001
Fetal Breathing Movements	1.12	1.02 - 1.24	*0.02
Fibronectin Levels	1.05	1.01 - 1.09	*0.04
Combined Model	0.38	0.22 - 0.64	<* 0.001

Table 3: Receiver operating characteristic (ROC) curve analysis of predictive tests

Parameter	AUC	95% Confidence Interval	p-value
Cervical Length	0.85	0.78 - 0.92	< 0.01
Fetal Breathing Movements	0.90	0.83 - 0.94	< 0.01
Fibronectin Levels	0.84	0.77 - 0.91	< 0.01
Combined Model	0.92	0.87 - 0.97	< 0.001

**Figure 2:** ROC AUC curve for predictive values

DISCUSSION

The research assessed how three clinical indicators namely fetal breathing movements together with cervical length measurements and vaginal fibronectin quantity help determine preterm labor risk for pregnant women during weeks 24 through 34 of gestation^{11,12}. Identification of preterm labour risk demands multiple parameter assessment because such methods prove more effective than screening with single indicators¹³.

Fetuses of women destined to deliver early exhibited reduced breathing movements compared to those with term pregnancies according to our analysis¹⁴. The research published by Pitts et al. (2021) in 2021 revealed that diminished breathing activity in the fetus corresponds to higher uterine irritability and shows an association with premature delivery¹⁵. The evaluated method of screening for risk of preterm birth through fetal breathing movements exhibited 90% sensitivity making it an efficient assessment tool¹⁶.

The preterm group presented with much shorter cervical length of 2.1 cm when evaluated using transvaginal ultrasound measurements compared to the term group with 3.4 cm¹⁷. Cervical lengths under 2.5 cm for pregnant women proved again to indicate

spontaneous premature birth¹⁸. The measured sensitivity of cervical length reached 85% and specificity reached 78% based on findings from our research¹⁹. The preterm labor group exhibited higher levels of fibronectin during testing which supports its position as a dependable preterm labor biochemistry marker. The research by Ikeoha et al. (2021) produced findings showing cervical-vaginal fibronectin rises associated with higher chances of premature birth²⁰. The outcomes from our tests show fibronectin manifests an 85% specificity and an 83% positive predictive value which demonstrates its application in clinical settings²¹. A logistic regression model combining these three predictors produced an important statistical outcome with a calculated odds ratio of 0.38 which proved significant for decreasing preterm labour risk when their values were beneficial ($p < 0.001$). The findings show that combining different diagnostic tests provides increased accuracy according to evidence presented by Muppa et al. (2024) in their meta-analysis research²².

Study Limitations: Due to its single-centre research design and small sample size of 110 subjects the study may have restricted the ability to generalize the results. The study did not perform long-term follow-up tests nor properly control key factors like maternal infections or socioeconomic elements or prior obstetric conditions that potentially affect preterm labour risk.

CONCLUSION

The findings from our research demonstrate that fetal breathing movement tests together with cervical length measurements and fibronectin testing create useful diagnostic methods for preterm labour. The integration of these examination variables improves prediction capabilities which might direct prompt medical actions to prevent complications from premature birth.

Authors Contributions

Qindeel Zahra: Conception and design, analysis and interpretation of data.

Noamia Ashraf: Analysis and interpretation of data, drafting the article.

Sadaf Zahra Syed: Acquisition of data, conception and design, analysis and interpretation.

Afroze Ashraf: Analysis and interpretation of data, proofreading.

Mahham Janjua: Conception and design, analysis and interpretation of data.

Quraa Mehmud: Analysis and interpretation of data, drafting the article.

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