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Original Research Article

Perinatal and neonatal outcomes in pregnancies with abnormal admission cardiotocography: a prospective observational study

Nafisa Ahamed*, Kakali Saha, Taslimul Jannat Flora, Momena Khatun, Salma Binte Bashir

Department of Obstetrics and Gynecology, Medical College for Women and Hospital, Uttara, Dhaka, Bangladesh

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***Correspondence:**
Dr. Nafisa Ahamed,
E-mail: ahmednafisa84@gmail.com

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ABSTRACT

Background: Admission cardiotocography (CTG) is widely used to screen for fetal compromise at the onset of labor, but its value in low-resource settings is uncertain. This study described maternal characteristics, CTG features, and adverse perinatal and neonatal outcomes in pregnancies with abnormal admission CTG at a tertiary hospital in Dhaka, Bangladesh.
Methods: This prospective observational study (October 2025 to March 2026) enrolled 140 consecutive women at 34 weeks' gestation or more in the first stage of spontaneous labor with a singleton cephalic fetus and an abnormal admission tracing, and followed them to delivery and immediate neonatal assessment. Tracings were classified as suspicious or pathological using the 2015 International Federation of Gynecology and Obstetrics criteria. Outcome frequencies were estimated with 95% confidence intervals (CIs), and the two groups were compared.
Results: Tracings were suspicious in 46 women (32.9%) and pathological in 94 (67.1%). Cesarean delivery was the most common outcome (77.1%; 95% CI, 69.5-83.3) and occurred in every woman with a pathological tracing. Meconium-stained amniotic fluid (28.6%), neonatal intensive care unit (NICU) admission (24.3%), and respiratory distress (21.4%) were frequent, whereas a 5-minute Apgar score below 7 (5.0%) and meconium aspiration syndrome (2.1%) were uncommon.
Conclusions: Among pregnancies with abnormal admission CTG, cesarean delivery was common, whereas severe immediate neonatal compromise was infrequent, although respiratory distress and NICU admission were relatively common. These descriptive findings do not establish the clinical utility of admission CTG.

Keywords: Cardiotocography, Cesarean section, Fetal heart rate, Pregnancy outcome, Neonatal intensive care, Bangladesh

INTRODUCTION

Maternal and newborn health is a major concern in Bangladesh. The national survey for 2022 shows a neonatal death rate of 20 per 1000 live births and a stillbirth rate of 22 per 1000 pregnancies.[1] Intrapartum hypoxia is a potentially preventable cause of adverse outcomes, and timely recognition of fetal compromise is key to reducing stillbirth, birth asphyxia, and neonatal sequelae.[2,3]

CTG is used to monitor the fetal heart rate and uterine activity, and a normal CTG trace indicates that the fetus is tolerating labor well.[4] The National Institute for Health and Care Excellence (NICE) 2022 guideline and the International Federation of Gynecology and Obstetrics (FIGO) 2015 consensus both categorize intrapartum tracings as normal, suspicious, or pathological on the basis of baseline rate, variability, and decelerations.[4,5] A short recording at admission in labor has been used to identify fetuses at risk of hypoxia, and several published studies have highlighted the importance of CTG monitoring.[2,5] Admission CTG is a commonly used screening test that aims to identify, at admission to the delivery unit, fetuses at increased risk of intrapartum hypoxia. However, in many Bangladeshi facilities, limited access to continuous

monitoring and confirmatory tests leaves the role of admission CTG uncertain. Randomized trials and pooled evidence comparing admission CTG with intermittent auscultation have found no clear neonatal benefit, and earlier evidence also raised concern about increased operative delivery.[6,7] Because continuous intrapartum monitoring has limited specificity, a limitation that frequently prompts unnecessary intervention, several adjunctive modalities have been proposed, including fetal blood sampling for pH and lactate, fetal scalp stimulation, and computer-based analysis of the fetal signal, typically interpreted against the FIGO criteria.[5,8] In low-resource settings such as Bangladesh, however, where the neonatal mortality rate remains high and fewer than 40% of women complete the recommended four antenatal visits, most of these technologies are rarely available in routine practice, leaving disciplined interpretation and management of the basic cardiotocograph as the most realistic route to improving perinatal outcomes.[1,9] A prospective study of 100 term women in northern India reported that admission CTG identified fetuses at risk of hypoxia with high specificity and negative predictive value in both low-risk and high-risk pregnancies, and concluded that the test is an effective and inexpensive means of detecting fetal hypoxia in developing countries.[10] However, evidence describing the outcome profile specifically among pregnancies presenting with abnormal admission CTG in Bangladesh remains limited.

This study aimed to describe maternal and obstetric characteristics, CTG features, and adverse perinatal and neonatal outcomes among pregnancies with abnormal admission CTG at a tertiary hospital in Dhaka, and to compare these features between suspicious and pathological tracings. Because the study was descriptive, no directional hypothesis was prespecified.

METHODS

Study design and participants

This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cohort studies. This single-arm prospective observational cohort study was conducted in the Department of Obstetrics and Gynecology, Medical College for Women and Hospital, a tertiary teaching hospital in Uttara, Dhaka, Bangladesh, from October 2025 to March 2026. Women were enrolled consecutively at 34 weeks' gestation or more if they were in the first stage of spontaneous labor with a singleton fetus in cephalic presentation. Exclusion criteria were multiple pregnancy, ultrasound-confirmed congenital anomaly, malpresentation, gestation below 34 weeks, an obstetric emergency requiring immediate cesarean delivery (e.g., placental abruption or cord prolapse), planned elective cesarean delivery, or refusal to participate. For this study, abnormal admission CTG was operationally defined as any tracing categorized by FIGO 2015 criteria as suspicious or pathological;[5] women with normal tracings were not enrolled. Participants were followed through delivery and immediate neonatal assessment.

Admission CTG and classification

Each participant underwent at least 20 minutes of fetal heart rate and uterine activity recording in a semi-lateral position using an external fetal monitor. Because all women were enrolled during the first stage of spontaneous labor, the admission recording constituted an intrapartum tracing; we therefore classified it using the FIGO 2015 intrapartum criteria, which are the most widely adopted standard for categorizing CTG in labor, as no separate admission-specific classification is established.[5] Under these criteria, tracings were classified using three features: baseline fetal heart rate, variability, and decelerations. A tracing was classified as normal when all three features met the criteria for normality, suspicious when it lacked at least one characteristic of normality but showed no pathological feature, and pathological when at least one pathological feature was present. The presence of accelerations was taken to indicate a fetus without hypoxia or acidosis, whereas their absence during labor was regarded as of uncertain significance.[5] Women with abnormal tracings underwent continued CTG surveillance, and delivery decisions followed unit protocols and the overall clinical assessment.

Data collection and variables

A structured case record form captured sociodemographic characteristics, obstetric history, medical history, examination findings, admission vital signs and fetal heart rate, delivery details, and neonatal outcomes. Outcomes included mode of delivery, meconium-stained amniotic fluid, Apgar score below 7, neonatal complications, and NICU admission. Individual CTG features were also recorded.

Sample size

The sample size was calculated to estimate the frequency of adverse perinatal outcomes among pregnancies with abnormal admission CTG using the single-population proportion formula. An expected frequency of adverse perinatal outcomes of 30% was assumed on the basis of a previous study.[11] At a 95% confidence level with 8% absolute precision, the calculation yielded a minimum required sample of 127. The final cohort of 140 women exceeded this threshold, corresponding to an approximate 95% confidence interval (CI) half-width of 7.6%.

Statistical analysis

Analyses were performed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA). Distributions of continuous variables were assessed with the Shapiro-Wilk test. Normally distributed data are reported as mean ± standard deviation and compared using Welch's t test; non-normally distributed data are reported as median

(interquartile range [IQR]) and compared using the Mann-Whitney U test. Categorical variables are reported as n (%) and compared using the χ^2 test, or Fisher's exact test when the expected cell count was below five. Wilson 95% CIs were calculated for proportions. All tests were two-sided, with $p<0.05$ considered statistically significant. Because the study was descriptive, p values were not adjusted for multiple comparisons and should be interpreted as exploratory rather than confirmatory. Complete-case analysis was used, and denominators reflect available observations. Comparisons of CTG features were descriptive because those features define the suspicious and pathological categories.

Ethical approval

The study was conducted in accordance with the Declaration of Helsinki (2013 revision). Ethical approval was obtained from the Institutional Ethical Review Board of the Medical College for Women and Hospital, Dhaka, Bangladesh (approval memo number MCWH/Ethical committee/2025/21(9), dated 23 August 2025). Written informed consent to participate was obtained from every participant before enrollment.

RESULTS

Sociodemographic characteristics

Among 140 women with abnormal admission CTG, 46 (32.9%) had suspicious tracings and 94 (67.1%) had pathological tracings. Sociodemographic characteristics were similar between groups (Table 1). Median maternal age was 26 years (IQR, 23-29). Most participants were Muslim (95.7%), urban residents (93.6%), homemakers (92.9%), and of middle socioeconomic status (93.6%). No group difference reached statistical significance.

Obstetric, clinical, and anthropometric characteristics

Most obstetric characteristics were similar between the groups (Table 2). Median gestational age was 38 weeks, mean gravidity was 1.9, 52.9% of pregnancies were high risk, and 98.6% of women had received antenatal care. Compared with women with suspicious tracings, those with pathological tracings had higher mean admission systolic (115.3 vs 109.8 mmHg; p=0.021) and diastolic blood pressure (74.6 vs 71.1 mmHg; p=0.049). No significant difference was found in the history of stillbirth or neonatal death, or in previous pregnancy complications. Some variables had missing observations; denominators are specified in the table notes.

Intrapartum CTG tracing features

The components of the admission tracing are shown in Figure 1. Because these components determine the tracing category, group differences are descriptive. Reduced or absent variability was more frequent in pathological tracings (78.7% and 10.6%, respectively) than in suspicious tracings (34.8% and 0%; $p<0.001$). Accelerations were absent in 67.0% of pathological versus 28.3% of suspicious tracings ($p<0.001$). Baseline tachycardia was also more frequent in the pathological group (18.1% vs 4.3%; p=0.026). The deceleration pattern differed between the groups (p=0.004), with prolonged decelerations occurring in pathological tracings only.

Delivery and neonatal outcomes

Mode of delivery differed by CTG category (Table 3). All women with pathological tracings underwent cesarean delivery, compared with 30.4% of those with suspicious tracings; the overall cesarean rate was 77.1% ($p<0.001$). Meconium-stained amniotic fluid occurred in 28.6% and a nuchal cord in 12.9%, without significant group differences. An Apgar score below 7 at 1 minute was more frequent after pathological than suspicious tracings (19.1% vs 0%; $p<0.001$), whereas a 5-minute Apgar score below 7 did not differ significantly (6.4% vs 2.2%; p=0.426). NICU admission was more frequent after pathological tracings (28.7% vs 15.2%; p=0.080), but the difference was not statistically significant. Respiratory distress was the most frequent neonatal complication (21.4%).

Absolute burden of adverse outcomes

Figure 2 shows the adverse outcome frequencies with their 95% CIs. Cesarean delivery was most frequent (77.1%; 95% CI, 69.5-83.3), followed by meconium-stained amniotic fluid (28.6%; 95% CI, 21.7-36.5), NICU admission (24.3%; 95% CI, 17.9-32.0), and respiratory distress (21.4%; 95% CI, 15.4-28.9). An Apgar score below 7 occurred in 12.9% of neonates at 1 minute and in 5.0% at 5 minutes. Meconium aspiration syndrome occurred in 2.1%.

Table 1: Sociodemographic characteristics by CTG classification.

Characteristics	Overall, (n=140)	Suspicious, (n=46)	Pathological, (n=94)	P value
Age (in years), median (IQR)	26.0 (23.0-29.0)	26.0 (23.0-29.8)	26.0 (23.0-29.0)	0.552
Religion				
Muslim	134 (95.7)	43 (93.5)	91 (96.8)	0.394
Hindu	6 (4.3)	3 (6.5)	3 (3.2)	
Educational qualification				
SSC or below	33 (23.6)	7 (15.2)	26 (27.7)	0.261
HSC	67 (47.9)	24 (52.2)	43 (45.7)	
Graduate or above	40 (28.6)	15 (32.6)	25 (26.6)	

Continued.

Characteristics	Overall, (n=140)	Suspicious, (n=46)	Pathological, (n=94)	P value
Occupation				
Homemaker	130 (92.9)	43 (93.5)	87 (92.6)	0.589
Service holder	2 (1.4)	0 (0.0)	2 (2.1)	
Others	8 (5.7)	3 (6.5)	5 (5.3)	
Area of residence				
Urban	131 (93.6)	42 (91.3)	89 (94.7)	0.476
Rural	9 (6.4)	4 (8.7)	5 (5.3)	
Socioeconomic condition				
Low	6 (4.3)	2 (4.3)	4 (4.3)	0.451
Middle	131 (93.6)	42 (91.3)	89 (94.7)	
High	3 (2.1)	2 (4.3)	1 (1.1)	

*Data are n (%) unless otherwise indicated. Continuous variables were compared using Welch's t test (mean ± SD) or the Mann-Whitney U test (median [IQR]); categorical variables were compared using the χ^2 test, or Fisher's exact test when expected cell counts were below five. CTG-cardiotocography; HSC-Higher secondary certificate; IQR-interquartile range; SSC-Secondary School Certificate.

Table 2: Obstetric, clinical, and anthropometric characteristics by CTG classification.

Characteristics	Overall, (n=140)	Suspicious, (n=46)	Pathological, (n=94)	P value
Obstetric history				
Gestational age, weeks, median (IQR)	38.0 (37.0–38.0)	37.0 (37.0-38.0)	38.0 (37.0-39.0)	0.094
Gravida, mean±SD	1.9±1.1	2.0±1.2	1.9±1.1	0.457
Para, mean±SD	0.7±1.0	0.9±1.1	0.6±0.9	0.136
Antenatal care attended	138 (98.6)	46 (100.0)	92 (97.9)	>0.99
High-risk pregnancy	74 (52.9)	27 (58.7)	47 (50.0)	0.333
History of stillbirth or neonatal death[a]	6 (6.5)	0 (0.0)	6 (10.2)	0.084
Previous pregnancy complication (any)	22 (15.7)	11 (23.9)	11 (11.7)	0.062
Clinical and vital signs				
Systolic BP, mmHg, mean±SD	113.5±11.7	109.8±12.6	115.3±10.8	0.021
Diastolic BP, mmHg, mean±SD	73.4±7.9	71.1±7.9	74.6±7.7	0.049
Maternal pulse, bpm, mean±SD	78.9±8.0	77.1±6.7	79.8±8.5	0.102
Respiratory rate, per min, median (IQR)	16.0 (14.0-18.0)	16.0 (14.2-18.0)	16.0 (14.0-18.0)	0.830
Anthropometric				
Symphysio-fundal height, cm, median (IQR)[b]	37.0 (36.0-38.0)	37.0 (36.0-38.0)	38.0 (36.0-38.0)	0.725
Admission FHR, bpm, median (IQR)	137.0 (132-144)	137.0 (134-140)	136.5 (130-146)	0.833

*Data are n (%) unless otherwise indicated. Continuous variables were compared using Welch's t test (mean ± SD) or the Mann–Whitney U test (median [IQR]); categorical variables were compared using the χ^2 test, or Fisher's exact test when expected cell counts were below five. [a]Data available for 92 women (33 suspicious and 59 pathological). [b]Data available for 86 women. BP, blood pressure; bpm, beats per minute; CTG, cardiotocography; FHR, fetal heart rate; IQR, interquartile range; SD, standard deviation.

Table 3: Delivery and neonatal outcomes by CTG classification.

Outcomes	Overall, (n=140)	Suspicious, (n=46)	Pathological, (n=94)	P value
Mode of delivery				
Vaginal	32 (22.9)	32 (69.6)	0 (0.0)	<0.001
Cesarean section	108 (77.1)	14 (30.4)	94 (100.0)	
Amniotic fluid color				
Clear	98 (70.0)	36 (78.3)	62 (66.0)	0.251
Meconium-stained	40 (28.6)	10 (21.7)	30 (31.9)	
Others	2 (1.4)	0 (0.0)	2 (2.1)	
Cord around the neck	18 (12.9)	3 (6.5)	15 (16.0)	0.117
Apgar score <7 at 1 min	18 (12.9)	0 (0.0)	18 (19.1)	<0.001
Apgar score <7 at 5 min	7 (5.0)	1 (2.2)	6 (6.4)	0.426
Neonatal complications				
None	105 (75.0)	36 (78.3)	69 (73.4)	0.144
Meconium aspiration syndrome	3 (2.1)	1 (2.2)	2 (2.1)	
Respiratory distress	30 (21.4)	7 (15.2)	23 (24.5)	
Others	2 (1.4)	2 (4.3)	0 (0.0)	
NICU admission	34 (24.3)	7 (15.2)	27 (28.7)	0.080

*Data are n (%). Categorical variables were compared using the χ^2 test, or Fisher's exact test when expected cell counts were below five. CTG, cardiotocography; NICU, neonatal intensive care unit.

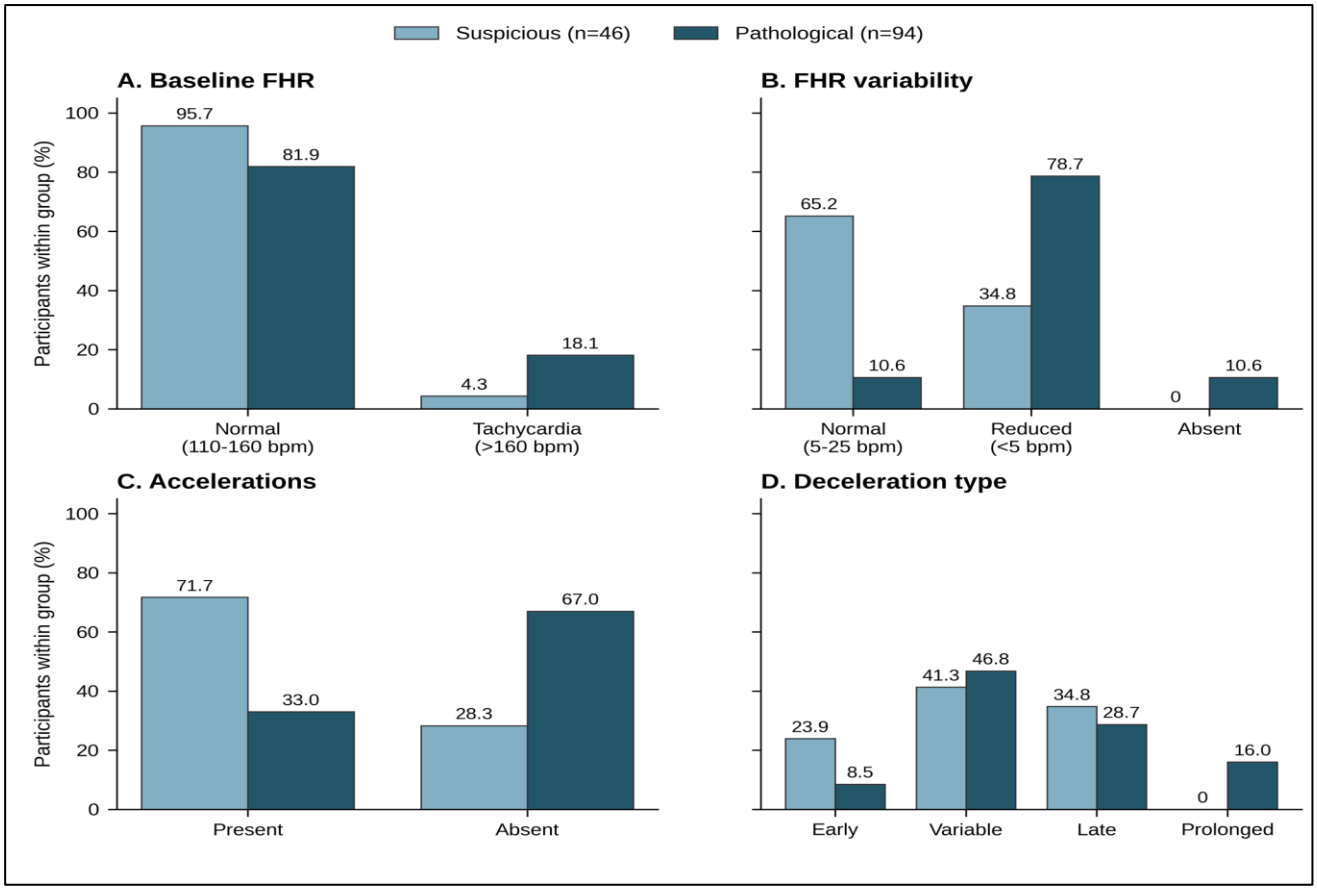


Figure 1: Intrapartum CTG tracing characteristics by classification. Within-group percentages for suspicious (n=46) versus pathological (n=94) tracings: (A) baseline fetal heart rate; (B) variability; (C) accelerations; (D) deceleration type. Because these features define the FIGO classification, the differences are descriptive rather than independent associations.

*CTG, cardiotocography; FHR, fetal heart rate; FIGO, International Federation of Gynecology and Obstetrics.

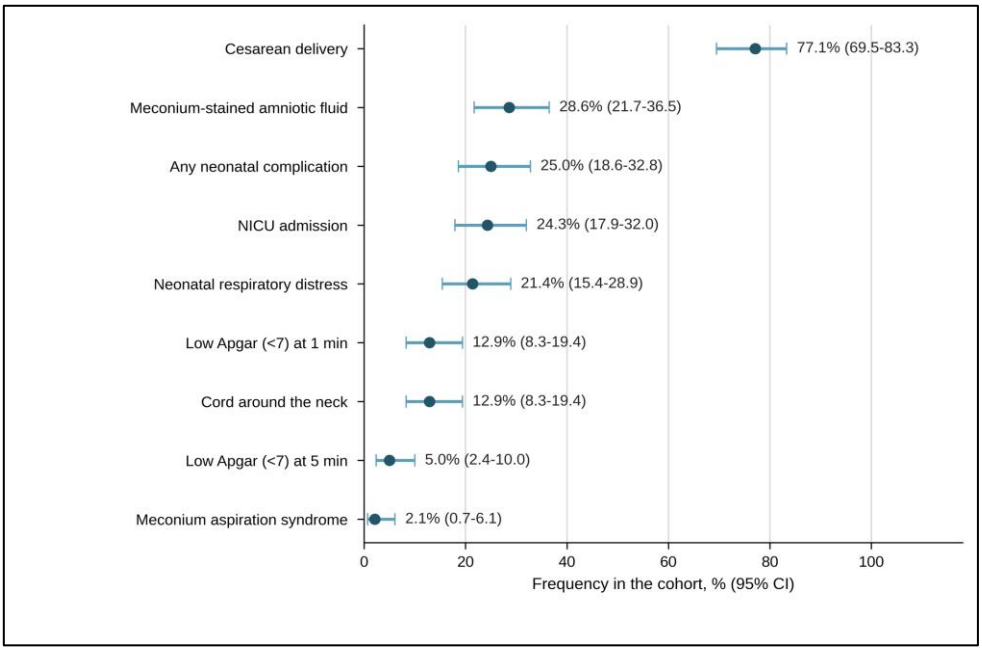


Figure 2: Adverse perinatal and neonatal outcome frequencies with 95% CIs (n=140).

*Point estimates (markers) with Wilson-score 95% CIs (horizontal bars) for each adverse outcome across the whole cohort, ordered by frequency. CI, confidence interval; NICU, neonatal intensive care unit.

DISCUSSION

In this prospective cohort of 140 pregnancies with abnormal admission CTG, cesarean delivery occurred in 77.1% of women. Meconium-stained amniotic fluid, respiratory distress, and other neonatal problems affected about a quarter of the cohort, although meconium aspiration syndrome and a 5-minute Apgar score below 7 were rare. High intervention rates therefore coexisted with generally reassuring immediate neonatal outcomes.

The association between pathological tracings and cesarean delivery is consistent with observational studies from comparable settings. In a prospective Indian study, cesarean delivery was the most common mode of delivery for ominous tracings, and abnormal CTG was associated with lower 1-minute Apgar scores and more NICU admissions.[10] In addition, a recent systematic review reported that abnormal admission CTG is associated with higher rates of cesarean and instrumental delivery, low Apgar scores, and NICU admission.[12] Our 24.3% NICU admission rate and 77.1% cesarean rate are comparable to those in the studies cited above.[10,12] Beyond mode of delivery, neonatal respiratory distress (21.4%) was roughly threefold the approximately 7% reported among term newborns generally, consistent with the selection for fetal compromise inherent in an abnormal CTG population. In contrast, the meconium-stained amniotic fluid rate (28.6%) fell within the range reported for term and post-term gestations.[13,14] Nevertheless, universal cesarean delivery after pathological tracings makes the mode of delivery a consequence of clinical decision-making rather than an independently predicted outcome.

Earlier randomized and pooled evidence suggested that admission CTG increased operative delivery without neonatal benefit.[6,7] An updated meta-analysis of five trials in low-risk term pregnancies found no significant increase in cesarean delivery (risk ratio, 1.09; 95% CI, 0.86-1.37) and no neonatal benefit.[15] Our cohort differs because it included only women with already abnormal tracings in a high-risk, resource-constrained setting. The study cannot determine whether the reassuring neonatal outcomes reflected false-positive tracings or timely intervention that prevented harm.

The differences in admission blood pressure are hypothesis-generating and should not be overinterpreted. These observations may inform hypotheses about cautious, guideline-based interpretation of abnormal admission tracings and, where available, adjunctive fetal assessment before operative delivery, but the present descriptive design cannot confirm the benefit of these approaches.

This study has several strengths, including the prospective and consecutive enrollment of participants, the standardized classification based on FIGO criteria, and the reporting of outcome frequencies alongside CIs within a population that is underrepresented in the literature. However, there are important limitations to consider. The single-center design and the lack of a normal-tracing comparison group prevented any assessment of diagnostic accuracy. In addition, because the tracing directly influenced clinical management, the decision for cesarean delivery was determined by the indication itself, which introduces confounding by indication. We did not formally assess inter-observer agreement in CTG interpretation, and we lacked objective measures of hypoxia such as umbilical cord blood pH. Reliance on complete-case analysis may have introduced bias, and the relatively modest sample size limits the precision of estimates for uncommon outcomes. Comparisons of tracing features were descriptive because those features defined the study categories. Finally, the cohort was predominantly urban (93.6%) and recruited at a single tertiary center with near-universal antenatal care attendance (98.6%), in contrast to the national figure of fewer than 40% of women completing the recommended four antenatal visits; this urban, tertiary, antenatal-care-engaged sample limits generalizability to the broader Bangladeshi population, particularly rural and community settings. Collectively, these limitations preclude causal or predictive conclusions.

CONCLUSION

Among pregnancies with abnormal admission CTG at this tertiary hospital in Dhaka, cesarean delivery was common, whereas severe immediate neonatal compromise was infrequent, although respiratory distress and NICU admission were relatively common. These descriptive findings characterize the perinatal and neonatal profile of this population but cannot establish the clinical utility of admission CTG. Larger multicenter cohorts that include women with normal tracings and objective measures of neonatal hypoxia are needed to determine predictive value.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee Medical College for Women and Hospital, Dhaka, Bangladesh (memo no. MCWH/Ethical committee/2025/21(9), dated 23 August 2025).

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