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Temporal and Spatial Epidemiology of Monkeypox (Mpox) in Plateau State of Nigeria

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ABSTRACT

Non-stress testing (NST) is one of the basic antepartum surveillance tests. It is being used as a tool for triage and intrapartum management in high-risk pregnancies; however, its utility and diagnostic performance as an admission test should be continually evaluated to optimize intrapartum management, triage, and prediction of perinatal outcomes.

To assess the use of the admission NST as a screening tool in high-risk pregnancies and find its correlation with intrapartum events, mode of delivery, and composite adverse perinatal outcomes.

They did an observational study of 107 high-risk pregnant women who were admitted for delivery. An admission NST was performed and classified into reactive or non-reactive, using the standard cardiotocographic parameters. Maternal, intrapartum, and perinatal outcomes were compared between the two groups. Diagnostic performance parameters (sensitivity, specificity, positive or negative predictive values) were computed, and a multivariable logistic regression analysis was used to determine the independent risk factors for adverse composite perinatal outcomes.

The 107 participants had a reactive admission NST (78.5%, n=84) and a non-reactive NST (21.5%, n=23). Operative deliveries were significantly higher in the non-reactive group (73.9% vs. 26.2%), and the rates of meconium-stained amniotic fluid (56.5% vs. 14.3%) and intrapartum fetal heart rate abnormalities (69.6% vs. 11.9%) were also significantly higher (all $p < 0.001$) in the non-reactive group. The non-reactive group had a higher rate of adverse composite perinatal outcomes (78.3%) than the reactive group (17.9%) ($p < 0.001$). The overall sensitivity, specificity, PPV, and NPV of the admission NST were 54.5%, 93.2%, 78.3%, and 82.1%, respectively, and the overall diagnostic accuracy was 81.3%. The non-reactive admission NST was the most important independent predictor of the adverse composite perinatal outcome (adjusted OR 11.42, 95% CI 3.28–39.75; $p < 0.001$) in multivariable logistic regression.

Admission NST is an important specific test which can be used to predict bad perinatal outcomes in high-risk pregnancies. A non-reactive NST is highly indicative of higher intrapartum fetal compromise, operative procedures, and bad neonatal outcomes. These results highlight the importance of the admission NST for clinical triage, risk stratification, and intrapartum decision-making process in high-risk obstetric populations.

Introduction

High-risk pregnancies include those in which there are risk factors from the mother and/or fetus that increase the likelihood of impaired perinatal outcomes such as intrapartum fetal compromise and/or

neonatal morbidity (1 – 3). Fetal surveillance is essential in these populations to be able to intervene at the right time. The non-stress test (NST) is one of the most commonly used tests for antepartum fetal monitoring because it is non-invasive, inexpensive, and has a high negative predictive value (4). The NST measures fetal acid-base status and the integrity of the fetal autonomic nervous system by determining fetal heart rate accelerations in association with fetal movements (5). Its role in routine antepartum surveillance is proved and its use as an admission test following hospital admission for delivery needs to be specifically assessed, especially in high-risk obstetric groups (6).

An admission test is one important screening measure at the entrance of the intrapartum period (7). Establishing a baseline fetal heart rate pattern on admission is very important in high-risk pregnancies to differentiate a fetus tolerating the intrauterine environment from one that is experiencing subclinical hypoxia (8). Reassurance of fetal wellbeing and allows routine intrapartum monitoring with a reactive NST. In contrast, a non-reactive admission NST is a useful red flag which should lead to more careful monitoring, intrauterine resuscitation, or delivery. Use of admission testing is still a subject of debate in spite of its common use, and it is recommended for use in high-risk situations and not as a routine tool for admission testing all women in labour (9, 10).

The clinical importance of the admission NST is that it can help to anticipate adverse intrapartum events and neonatal outcomes (11). Fetal heart rate abnormalities, operative deliveries, increased risk for meconium-stained amniotic fluid, and adverse composite perinatal outcomes (such as low Apgar scores, admission to the neonatal intensive care unit, and perinatal mortality) are commonly associated with a non-reactive trace (12, 13). The aim of this study is to evaluate, in a comprehensive manner, the utility of the NST as an instrument of screening for admission in high-risk pregnancies to compare its association with intrapartum interventions with the composite adverse perineal outcome, aimed at optimizing risk stratification and improving the care for neonates.

Method

The aim of the study was to assess the diagnostic value of the non-stress test (NST) in high-risk pregnancies in a cross-sectional study. The study group included 107 pregnant women who were admitted for delivery and were at 34 weeks or more of gestation. Patients with at least one risk factor for labour and delivery were recruited, such as those who had had prior pregnancy complications, those who were oligohydramios, those who had signs of fetal growth restriction, those who had maternal anaemia, decreased fetal movements, those who had gestational diabetes, those who had pre-labour rupture of the membranes, those who had high blood pressure, those who were postdated, and those who had some other systemic medical disorder. Obstetric and baseline sociodemographic and anthropometric data were systematically collected at admission.

A standard cardiotocographic (CTG) assessment was carried out as the admission NST for all participants at the time of hospital admission. It was originally given for 20 minutes. At least 2 fetal heart rate (FHR) accelerations of 15 beats per minute or more, each lasting at least 15 seconds in the 20-minute period, were considered a reactive NST. The initial 20-minute tracing was not met the criteria of a reactive NST, was extended to 40 minutes, and given a final non-reactive interpretation. All CTG measurements were carefully recorded, analyzed, and compared to the reactive and non-reactive groups, such as baseline FHR, baseline tachycardia or bradycardia, baseline variability, and presence of early, variable, or late decelerations.

Maternal, intrapartum, and neonatal information was gathered and analyzed. Intrapartum outcomes evaluated were mode of delivery, indication for cesarean section, color of the amniotic fluid, presence of intrapartum FHR abnormalities, need for intrauterine resuscitation, and admission-to-delivery interval. Perinatal outcomes assessed included birth weight, Apgar score at 1 and 5 minutes, the

requirement for active neonatal resuscitation, umbilical artery pH, the need for admission to the NICU, length of NICU stay, and certain neonatal morbidities including meconium aspiration syndrome, hypoxic-ischaemic encephalopathy, neonatal seizures, and perinatal death. The primary endpoint was an adverse composite perinatal outcome, defined as having one or more of the following: Apgar score less than 7 at five minutes, need for positive pressure ventilation, umbilical artery pH less than 7.10, and NICU admission for more than 24 hours, meconium aspiration syndrome, hypoxic-ischaemic encephalopathy, neonatal seizures, or perinatal death.

Data were analyzed in SPSS 26.0. Admission NST to predict the adverse composite perinatal outcome was calculated, and the sensitivity, specificity, PPV, NPV, DA, LR+ and LR- were determined, along with Youden's index. In addition, univariable and multivariable binary logistic regression was performed to determine independent predictors of the composite adverse outcome. Variables with a P value < 0.10 in the univariable analysis were included in the multivariable model. A p-value of less than 0.05 was considered to be a level of statistical significance.

Results

Table 1: Baseline demographic and obstetric characteristics of the 107 patients.

Variable	Mean ± SD	n (%)
Maternal age (years)	26.4 ± 4.3	—
≤20 years	—	9 (8.4)
21–30 years	—	74 (69.2)
>30 years	—	24 (22.4)
Body mass index (kg/m²)	24.8 ± 3.2	—
Gestational age at admission (weeks)	38.2 ± 1.6	—
34+0–36+6 weeks	—	14 (13.1)
37+0–39+6 weeks	—	74 (69.2)
≥40+0 weeks	—	19 (17.8)
Gravidity	1.9 ± 1.0	—
Parity		
Primigravida	—	58 (54.2)
Multigravida	—	49 (45.8)
Haemoglobin at admission (g/dL)	10.6 ± 1.4	—
Amniotic fluid index (cm)	10.9 ± 3.6	—
Antenatal registration status		
Booked (≥4 antenatal visits)	—	71 (66.4)
Unbooked / referred	—	36 (33.6)
Residence		
Urban	—	62 (57.9)
Rural	—	45 (42.1)
Socioeconomic class (modified Kuppuswamy)		
Upper / upper-middle	—	16 (15.0)
Lower-middle	—	52 (48.6)
Upper-lower / lower	—	39 (36.4)
Mode of onset of labour		
Spontaneous	—	61 (57.0)

Induced	—	32 (29.9)
Elective caesarean before labour	—	14 (13.1)

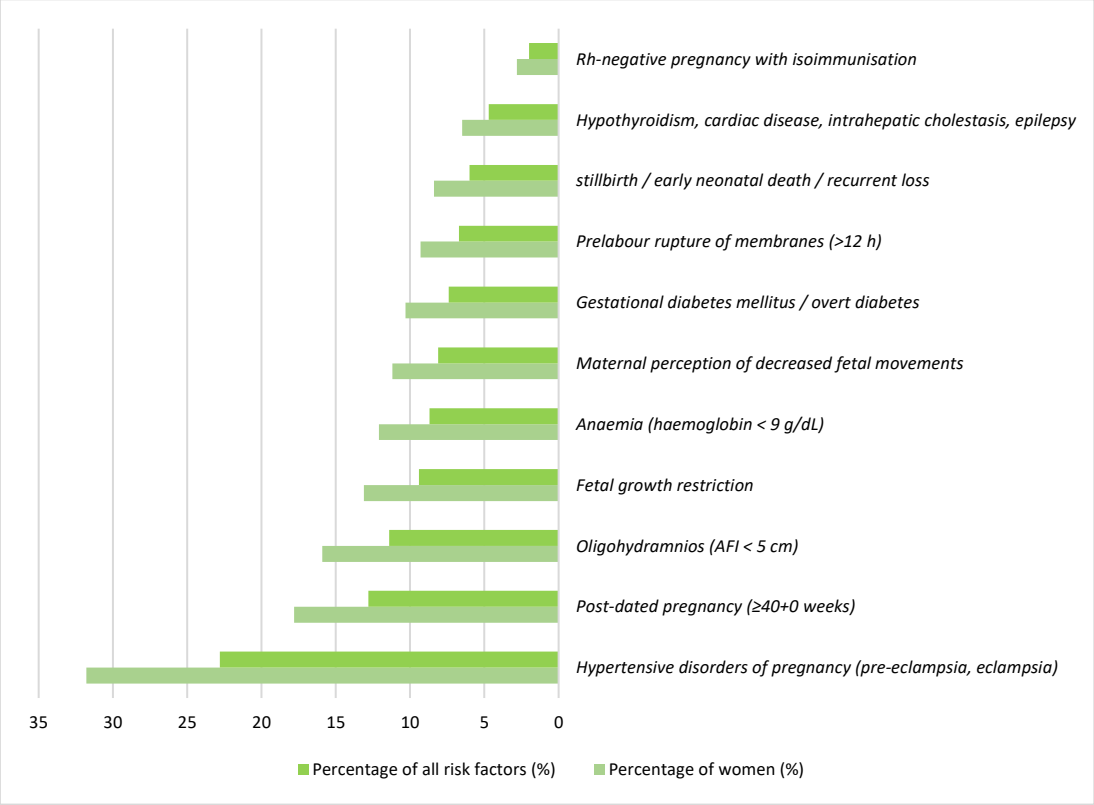

Figure 1: Classification of the high-risk factors into all patients enrolled in this study.

Table 2: Identifying the clinical characteristics of admission NST and cardiotocography outcomes in both patients who were reactive versus non-reactive.

Cardiotocographic parameter	Reactive NST (n = 84)	Non-reactive NST (n = 23)	p value
Admission NST result, n (%)	84 (78.5)	23 (21.5)	—
Baseline FHR, mean ± SD (bpm)	141.3 ± 8.2	148.6 ± 14.7	0.003
Baseline FHR, median (IQR) (bpm)	140 (136–146)	148 (139–158)	0.004
Baseline tachycardia >160 bpm, n (%)	1 (1.2)	6 (26.1)	<0.001
Baseline bradycardia <110 bpm, n (%)	0 (0.0)	3 (13.0)	0.008
Baseline variability <5 bpm, n (%)	2 (2.4)	9 (39.1)	<0.001
≥2 accelerations ≥15 bpm for ≥15 s in 20 min, n (%)	84 (100.0)	4 (17.4)	<0.001
Any deceleration, n (%)	3 (3.6)	13 (56.5)	<0.001
Early decelerations, n (%)	2 (2.4)	3 (13.0)	0.070
Variable decelerations, n (%)	1 (1.2)	8 (34.8)	<0.001
Late decelerations, n (%)	0 (0.0)	5 (21.7)	<0.001
Sinusoidal/prolonged deceleration pattern, n (%)	0 (0.0)	2 (8.7)	0.043
Test extended to 40 min before final interpretation, n (%)	12 (14.3)	19 (82.6)	<0.001

Admission-to-delivery interval, mean ± SD (h)	11.4 ± 6.8	6.9 ± 5.4	0.004
Admission-to-delivery interval, median (IQR) (h)	10.0 (6.0–15.5)	5.0 (2.5–9.0)	0.002

Table 3: Enrollment and hospitalization outcomes among all patients.

Outcome	Reactive NST (n = 84), n (%)	Non-reactive NST (n = 23), n (%)
Mode of delivery		
Spontaneous vaginal delivery	62 (73.8)	6 (26.1)
Instrumental vaginal delivery (vacuum/forceps)	6 (7.1)	3 (13.0)
Caesarean section	16 (19.0)	14 (60.9)
Operative delivery (instrumental + caesarean)	22 (26.2)	17 (73.9)
Indication for caesarean section		
Non-reassuring fetal status / fetal distress	7 (8.3)	12 (52.2)
Non-progress of labour / cephalopelvic disproportion	5 (6.0)	1 (4.3)
Obstetric/maternal indication (severe pre-eclampsia, malpresentation, previous scar)	4 (4.8)	1 (4.3)
Amniotic fluid colour		
Clear	72 (85.7)	10 (43.5)
Thin meconium	8 (9.5)	5 (21.7)
Thick meconium	4 (4.8)	8 (34.8)
Meconium-stained amniotic fluid (any grade)	12 (14.3)	13 (56.5)
Intrapartum FHR abnormality on continuous monitoring	10 (11.9)	16 (69.6)
Intrauterine resuscitation measures instituted	14 (16.7)	18 (78.3)
Delivery within 6 h of admission	21 (25.0)	15 (65.2)
Postpartum haemorrhage	6 (7.1)	2 (8.7)
Maternal ICU/HDU admission	3 (3.6)	2 (8.7)

Table 4: Perinatal outcome of 107 patients.

Perinatal outcome	Reactive NST (n = 84)	Non-reactive NST (n = 23)
Birth weight (kg), mean ± SD	2.78 ± 0.44	2.61 ± 0.51
Birth weight (kg), median (IQR)	2.80 (2.50–3.05)	2.60 (2.25–2.95)
Low birth weight <2500 g, n (%)	17 (20.2)	8 (34.8)

Apgar score at 1 min, mean ± SD	7.6 ± 1.2	5.9 ± 1.9
Apgar score at 1 min <7, n (%)	9 (10.7)	13 (56.5)
Apgar score at 5 min, mean ± SD	8.9 ± 0.8	7.6 ± 1.7
Apgar score at 5 min <7, n (%)	3 (3.6)	8 (34.8)
Need for active resuscitation (positive-pressure ventilation ± intubation), n (%)	8 (9.5)	12 (52.2)
Umbilical artery pH <7.10 at birth, n (%)	5 (6.0)	9 (39.1)
NICU admission, n (%)	11 (13.1)	14 (60.9)
Duration of NICU stay (days), mean ± SD	4.2 ± 2.6	6.8 ± 4.1
Meconium aspiration syndrome, n (%)	2 (2.4)	5 (21.7)
Hypoxic–ischaemic encephalopathy (any stage), n (%)	2 (2.4)	5 (21.7)
Neonatal sepsis (culture-positive or probable), n (%)	5 (6.0)	3 (13.0)
Neonatal seizures, n (%)	1 (1.2)	4 (17.4)
Fresh stillbirth, n (%)	0 (0.0)	1 (4.3)
Early neonatal death (<7 days), n (%)	1 (1.2)	3 (13.0)
Perinatal death (stillbirth + early neonatal death), n (%)	1 (1.2)	4 (17.4)
Adverse composite perinatal outcome, n (%)	15 (17.9)	18 (78.3)
Healthy neonate discharged with mother, n (%)	69 (82.1)	5 (21.7)

Table 5: A multivariable logistic regression in predication of adverse perinatal outcome.

Predictors	Total, n (%)	Adjusted OR (95% CI)	*p* value
Non-reactive admission NST (vs reactive)	18/23 (78.3)	11.42 (3.28–39.75)	<0.001
Meconium-stained amniotic fluid (vs clear)	17/25 (68.0)	3.02 (1.05–8.69)	0.040
Hypertensive disorder of pregnancy (vs absent)	15/34 (44.1)	2.41 (0.88–6.60)	0.087
Oligohydramnios, AFI <5 cm (vs AFI ≥5 cm)	9/17 (52.9)	2.76 (0.81–9.42)	0.105
Birth weight <2500 g (vs ≥2500 g)	13/25 (52.0)	2.58 (0.88–7.55)	0.084
Fetal growth restriction (vs absent)	7/14 (50.0)	1.62 (0.42–6.25)	0.484
Unbooked / referred status (vs booked)	15/36 (41.7)	1.74 (0.65–4.66)	0.271
Gestational age <37 weeks (vs ≥37 weeks)	7/14 (50.0)	Not entered	—
≥2 coexisting high-risk factors (vs single factor)	13/33 (39.4)	Not entered	—
Primigravida (vs multigravida)	19/58 (32.8)	Not entered	—
Maternal age >30 years (vs ≤30 years)	8/24 (33.3)	Not entered	—
Anaemia, Hb <9 g/dL (vs ≥9 g/dL)	5/13 (38.5)	Not entered	—

Discussion

One hundred and seventy high-risk pregnant women (107) who were admitted in early labour or for elective safe confinement were enrolled in the study and underwent a 20-minute cardiotocographic non-stress test (NST). No mothers or mother- baby pairs would be lost to follow-up, and there was 100% follow-up in terms of mother–infant outcomes being available. Our results have shown that a non-reactive admission NST is strongly correlated with immediate fetus' compromise requiring the prompt

implementation of obstetric interventions and leads to an increased neonatal morbidity rate. In particular, in those who had a non-reactive trace, operative delivery occurred more often (73.9% versus 26.2%), meconium-stained amniotic fluid was more common (56.5% versus 14.3%), and there was a significantly higher incidence of adverse composite perinatal outcomes (78.3% versus 17.9%). The mean maternal age of the study population was 26.4 ± 4.3 years (median 26.0, IQR 23.0–29.0; range 19–38 years), and the mean gestational age at admission was 38.2 ± 1.6 weeks (median 38.3, IQR 37.2–39.3). The majority of the women (54.2%) were primigravidae, while 33.6% of women were unbooked/referred cases. Fourteen women (13.1%) were late preterm (34+0–36+6 weeks) at admission (Table 1). Of the 107 women, 149 high-risk factors were reported; the mean number per woman was 1.39 ± 0.58, with 33 women (30.8%) having 2 or more coexisting factors. The largest risk group was the same for hypertensive disorders of pregnancy (34), accounting for 31.8% of all participants; post-datism (19, 17.8%) and oligohydramnios (17, 15.9%) were the next largest risk groups (Table 2). Samples collected and sent for admission were NST in 84 women (78.5%) and non-reactive in 23 women (21.5%). Of the 23 non-reactive tracings, reduced baseline variability (<5 bpm) was observed in 9 (39.1%), and decelerations in any form were observed in 13 (56.5%), of which five (21.7%) recorded late decelerations. The mean baseline fetal heart rate was significantly higher in the non-reactive group (148.6 ± 14.7 vs 141.3 ± 8.2 bpm; p = 0.003) (Table 3).

The overall rate of caesarean delivery was 30 (28.0%), while it was significantly higher in non-reactive NST (14/23, 60.9%) than in reactive NST (16/84, 19.0%) (p<0.001). Caesarean section specifically for non-reassuring fetal status occurred in 12 of 23 women (52.2%) with a non-reactive test versus 7 of 84 (8.3%) with a reactive test (OR 12.00, 95% CI 4.06–35.45; p < 0.001). Meconium-stained amniotic fluid was present in 56.5% of the non-reactive group compared to 14.3% of the reactive group (p<0.001) (Table 4). The non-reactive group was consistently and significantly more likely to have an adverse outcome of the perinatal period. A 5-minute Apgar score <7 occurred in 34.8% versus 3.6% (p < 0.001), NICU admission in 60.9% versus 13.1% (p < 0.001), and hypoxic–ischaemic encephalopathy in 21.7% versus 2.4% (p = 0.003). Inherently, there were 5 perinatal deaths (1 fresh stillbirth, 4 early neonatal deaths) with a perinatal mortality rate of 46.7 per 1000 births, 4 of which (80.0%) were admitted non-reactive. Mean birth weight did not differ significantly between the groups (2.61 ± 0.51 vs 2.78 ± 0.44 kg; p = 0.113) (Table 5).

The non-reactive cohort had significantly higher baseline fetal HR, more accelerations and decelerations, less baseline variability, and more variable and late decelerations. The results of these tests concur with some studies in America (14 – 16) that have seen that a non-reactive NST may be indicative of a fetus with reduced physiological reserve, and unable to sustain homeostasis before the beginning of uterine contractions. It is not surprising, therefore, that these fetuses were less tolerable to labor, as evidenced by the significantly higher amount of intrapartum fetal heart rate abnormalities (69.6% vs. 11.9%) and intrauterine resuscitation experienced (78.3% vs. 16.7%). The effect of a non-reactive admission NST was dramatic with regard to neonatal morbidity markers, but not so clear with regard to perinatal outcome. Compared to the non-reactive group, neonates had significantly lower 1-minute and 5-minute Apgar scores, a higher percentage of those needing active resuscitation (52.2% compared to 9.5%), and a higher number of those with severe acidemia (umbilical artery pH <7.10, 39.1% compared to 6%). Moreover, the incidence of meconium aspiration syndrome, hypoxic-ischemic encephalopathy, neonatal seizures, and perinatal death was significantly increased in this group (17). These findings support the Chinese studies focusing on the fetal autonomic integrity as a key feature of the NST, but also show the NST's predictive value for hard neonatal outcomes in high-risk pregnancies (18 – 20). As seen in our data, the non-reactive group suffered from neonatal intensive care unit (NICU) admissions and longer hospitalization, with 60.9% admitted to NICU while 13.1% of the reactive group

were admitted to NICU. This finding was corroborated by an earlier study in France (21), which showed that data on non-reactive admission traces were strong indicators of admission to NICU as well as length of NICU stay.

Moderate sensitivity (54.5%) and excellent specificity (93.2%), high positive predictive value (PPV) (78.3%) and high negative predictive value (NPV) (82.1%). This diagnostic profile is very much in line with one carried out in the UK on admission testing (22). The high specificity and PPV suggest that a non-reactive NST is a good predictor of fetal viability and should limit the false alarms that result from a non-reactive NST, allowing clinical resources and accelerated deliveries to be focused on the truly compromised fetus (23). In contrast, this high NPV gives great clinical reassurance, as a reactive admission NST effectively excludes a significant immediate fetal compromise, permitting normal intrapartum monitoring and the option of avoiding unnecessary operative procedures. The multivariable analysis offered valuable information on the independent value of the admission NST (24). The non-reactive NST was the strongest independent predictor (and remained after adjustments for the other adverse risk factors (25), such as oligohydramnios, meconium-stained fluid and hypertensive disorder, aOR 11.42). This implies that the sum of these multiple maternal and fetal risk factors is being recorded and documenting the cumulative real-time physiological effect of these factors as seen in the admission NST. A non-reactive NST does not mean that the fetus is decompensating, but a diagnosis of preeclampsia or fetal growth restriction means that there is some risk of fetal decompensation.

Conclusion

Twenty-three of 107 women with high risk (21.5%) had a non-reactive NST. Also, there was a 3-fold increase in caesarean delivery rate and a 6-fold increase in caesarean section for non-reassuring fetal status in non-reactive tracings as compared to the other groups. Moreover, an adverse composite perinatal outcome was experienced in 78.3% of the non-reactive group and 17.9% of the reactive group. Further, the admission NST had significant values of negative predictive value (82.1%) and specificity (93.2%), with a moderate sensitivity (54.5%) for adverse composite perinatal outcome. A reactive test gave good short-term reassurance and gave a true indication of a high-risk subgroup for intensified surveillance because of a non-reactive test. The non-reactive admission NST was the strongest independent risk factor for adverse perinatal outcome on multivariable logistic regression (adjusted OR 11.42, 95% CI 3.28–39.75) in addition to the other factors (meconium staining, hypertensive disease, oligohydramnios and birth weight).

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