Trends and risk factors in tribal vs nontribal preterm deliveries in Gujarat, India

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BACKGROUND: Although risk factors of preterm deliveries across the world have been extensively studied, the trends and risk factors of preterm deliveries for the population of rural India, and specifically tribal women, remain unexplored.

OBJECTIVE: The aim of this study was to assess and compare the preterm delivery rates among women from a rural area in Gujarat, India, based on socioeconomic and clinical factors. The second aim of the study was to assess and identify predictors or risk factors for preterm deliveries.

STUDY DESIGN: This was a retrospective medical record review study investigating deliveries that took place at the Kasturba Maternity Hospital in Jhagadia, Gujarat, from January 2012 to June 2019 (N=32,557). We performed odds ratio and adjusted odds ratio analyses of preterm delivery risk factors. Lastly, we also considered the neonatal outcomes of preterm deliveries, both overall and comparing tribal and nontribal mothers.

RESULTS: For the study period, the tribal preterm delivery rate was 19.7% and the nontribal preterm delivery rate was 13.9%; the rate remained consistent for both groups over the 7-year study period. Adjusted odds ratios indicated that tribal status (adjusted odds ratio, 1.16; 95% confidence interval, 1.08−1.24), maternal illiteracy ((adjusted odds ratio, 1.29, 95% confidence interval, 1.18−1.42), paternal illiteracy (adjusted odds ratio, 1.27; 95% confidence interval, 1.15−1.410), hemoglobin <10 g/dL (adjusted odds ratio, 1.41; 95% confidence interval, 1.32−1.51), and a lack of antenatal care (adjusted odds ratio, 2.15; 95% confidence interval, 1.94−2.37) are significantly associated with higher odds of preterm delivery. The overall stillbirth rate among tribal women was 3.06% and 1.73% among nontribal women; among preterm deliveries, tribal women have a higher proportion of stillbirth outcomes (11.77%) than nontribal women (8.86%).

CONCLUSION: Consistent with existing literature, risk factors for preterm deliveries in rural India include clinical factors such as a lack of antenatal care and low hemoglobin. In addition, sociodemographic factors, such as tribal status, are independently associated with higher odds of delivering preterm. The higher rates of preterm deliveries among tribal women need to be studied further to detail the underlying reasons of how it can influence a woman's delivery outcome.

Key words: India, maternal health, preterm, tribal, rural health, South Asia, vulnerable populations

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Introduction

The World Health Organization (WHO) defines preterm birth as all births before 37 weeks of gestation.[1] Globally, the complications associated with preterm birth were the leading cause of death in children younger than 5 years of age in 2016, accounting for approximately 16% of all deaths and 35% of deaths among newborn babies; preterm births are the second most common cause of death in children under the age of 5 years after pneumonia.[2,3] Worldwide, an estimated 11.1% (14.9 million) of all livebirths in 2010 were born prematurely, with preterm birth rates increasing in most countries with reliable trend data.[3] Although the risks of mortality and morbidity are much higher in early preterm birth (<34 weeks), late preterm birth (34<37 weeks) occurs more often and newborn babies born late preterm have significantly higher risks of adverse outcomes than babies born at term.[4] The global burden of prematurity is not distributed equally, because preterm birth is more common in low- and middle-income countries and the probability of survival is lower in these countries than in high-income countries.[5]

Globally, preterm delivery has been extensively studied. Established preterm delivery risk factors include a previous preterm birth, previous cervical surgery, multiple dilations and evacuations, uterine anomalies, <17 or >35 years of age, lower educational level, unmarried, lower socioeconomic status, short pregnancy interval, body mass index (BMI) <19 kg/m^2, poor nutritional status, long working hours, hard physical labor, adverse behaviors (smoking), maternal medical conditions, or fetal disorders.[6]

A recent *British Medical Journal* article detailing a survey of stillbirths across 9 states in India reported that the preterm birthrate is about 10%, whereas the Healthy Newborn Network

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Why was this study conducted?
The delivery trends and outcomes for rural women in India are understudied; our study aimed to understand the risk factors faced by tribal women who deliver prematurely in rural India.

Key findings
Over the study period, the tribal preterm delivery rate was 19.7% and the nontribal preterm delivery rate was 13.9%. The adjusted odds ratio indicates that tribal status, maternal illiteracy, paternal illiteracy, anemia, and a lack of antenatal care are significantly associated with higher odds of preterm delivery in this population.

What does this add to what is known?
Consistent with existing literature, risk factors for preterm deliveries in rural India include clinical factors such as a lack of antenatal care and low hemoglobin. In addition, sociodemographic factors such as tribal status are independently associated with higher odds of delivering prematurely. The higher rates of preterm deliveries among tribal women need to be studied further to detail the underlying reasons of how it can influence a woman's delivery outcome.

estimates that the India-wide preterm delivery rate is 13%.[7,8]

However, the preterm delivery rates of rural tribal women in India is not as extensively studied. There is a need to understand this context in more detail, especially because of the inequitable access to obstetrical and neonatal care faced by patients in rural and tribal areas.[9] The tribal population accounts for 8.6% (104 million) of the total population in India.[10] Scheduled tribe is a government designation of specific indigenous peoples, and this designation is an important social determinant of health in the country.[11] Because of geographic isolation, social marginalization, and living in economically disadvantaged areas, tribal communities face barriers to healthcare. In the western state of Gujarat, the tribal population makes up 14.5% of the population.[12] The health of tribal populations in India is generally understudied, although they bear a disproportionately greater burden of disease because of a lack of access to services.[13–15] Information on preterm risk factors and predictors for rural tribal women will be useful for clinicians and public health practitioners to improve maternal health and neonatal outcomes in tribal regions in India and other areas with similar needs.

This retrospective medical record review study aimed to investigate preterm deliveries in the community-based hospital of the Kasturba Maternity Hospital (KMH), Society for Education Welfare and Action (SEWA) Rural in Gujarat. The main aim of this study was to assess and compare the delivery outcomes in tribal vs nontribal women from this geographic area based on a variety of socioeconomic and clinical factors. The second aim of the study was to assess and identify predictors and risk factors for preterm deliveries in both groups.

Material and Methods
Study setting
Since 1980, the 200-bed KMH has been serving the surrounding 2500 villages. The KMH is run by SEWA Rural, a nonprofit healthcare association focused on maternal and child health interventions for a rural tribal population in the block of Jhagadia and the surrounding areas in the western state of Gujarat.

Jhagadia lies within the district of Bharuch and is located in a tribal belt that stretches along the eastern border of Gujarat. Its population is 185,337, comprising predominantly tribal populations.[16] The town of Jhagadia is 2 km south of the Narmada River. Apart from agriculture, a designated state industrial zone within the district is the

main source of employment. Poverty, illiteracy, and ill health are highly prevalent. The KMH provides free or highly subsidized clinical services to pregnant women and newborns with the support of government insurance schemes, grants, and donations. The hospital operates as a designated "First Referral Unit" and is the largest provider of maternal healthcare in the Bharuch district and nearby areas.

Methods
This was a retrospective medical record review study that investigated deliveries at the KMH from January 2012 to June 2019 (N=32,557). De-identified data were extracted from the KMH electronic medical record system into Microsoft Excel 2019 (Microsoft Corporation, Redmond, WA). The complete set of variables extracted included year, age, marital status, date of admission, time of admission, booked, blood group, hemoglobin at registration, sickling, religion, caste, education of patient, education of husband, occupation of patient, occupation of husband, delivery date, delivery time, twins, outcome, sex, birthweight, cry, type of delivery, gestational age, gravida, para, induction, number of live male children, number of live female children, age of last child, and diagnosis.

The hospital maintains a registry of all admissions that is maintained by care providers and subsequently digitized by trained staff. A team of care providers, including gynecologists, ensure the accuracy of the entire dataset, including that of indications and outcomes of all deliveries. Licensed obstetrician-gynecologists determined the diagnoses and had access to the entire medical record, including gestational dating. The inclusion criteria were delivery at KMH between 2012 and 2019. We excluded women who were at the hospital for other types of maternal admissions (eg, antenatal care or pregnancy termination). We used the definition of preterm deliveries given by the WHO as any delivery between 24 weeks and 37 completed weeks of gestation. For gestational dating, last menstrual period (LMP) or ultrasound

dating was used when possible. The estimated due date (EDD) was changed to the ultrasound dating if the difference in the EDD based on the ultrasound reading was more than 1 week different from the EDD based on LMP for the first trimester, 2 weeks different in the second trimester, and 3 weeks in the third trimester. If the EDD by ultrasound was within the limit of margin of error, the EDD calculated by LMP was used to determine gestational age. The definition of a Scheduled Tribe according to the specifications of the Government of India, which is outlined in Article 342 of the Indian Constitution, is allowing State and Union territories to specify groups as "Scheduled Tribe." The broad characteristics are groups that are geographically isolated, have a distinct culture, and are economically disadvantaged. Designations that are considered "nontribal" for the purposes of this study are Scheduled Caste, "Other Backward Caste" (OBC), and "Other," which is inclusive of economically privileged groups. Scheduled Caste and OBC are also traditionally economically disadvantaged but have distinct social histories related to Scheduled Tribes.[17]

This study was approved by the SEWA Rural Institutional Ethics Committee (IEC). The SEWA Rural IEC reviewed these data and allowed their use for analyses and publication. The IEC also waived the need for informed consent from the patient on the basis that this is a retrospective data of medical record review and the anonymity of the patients is maintained through a de-identified dataset. Brown University Institutional Review Board approved an authorization agreement to cede review to SEWA Rural Independent Ethics Committee.

Independent and dependent variables

Delivery outcome was the primary dependent variable and was categorized as term or preterm. Per the WHO definition, preterm delivery is defined as delivery before 37 weeks of pregnancy and is also the clinical definition used at the KMH. The potential risk factors for

preterm delivery were the independent variables, including maternal age, tribal status, parity, maternal illiteracy, paternal illiteracy, marital status, antenatal care, hemoglobin level, and hypertension at delivery. Maternal and paternal illiteracy is defined in the medical record as those who cannot read or write; all others who could read or write and had some level of education were considered literate. Antenatal care is an ordinal variable indicating that the mother had at least 1 clinic visit during the pregnancy. Hypertension is coded in the medical record as "gestational hypertension." Gestational hypertension is coded in the medical record as those with blood pressure >140 mm Hg systolic and >90 mm Hg diastolic without proteinuria. Gestational hypertension and preeclampsia are 2 separate diagnoses in the medical record system.

For neonatal outcomes, we looked at live births and stillbirths. Stillbirths are defined as births at a gestational age of ≥24 weeks to a fetus showing no signs of life with a fetal weight of 500 g. Within the live birth cohort, we looked at whether babies had an immediate cry, spontaneous breathing after bag and mask ventilation, or birth asphyxia using the clinical definition of requiring advanced resuscitation such as intubation, cardiac massage, and drugs. The KMH follows a standard protocol for newborn resuscitation in that regardless of gestational age, if a neonate does not cry after drying off, suctioning, or stimulation, providers proceed to place a bag valve mask, then provide oxygen, and then perform a more invasive intervention.

Statistical analyses

The potential risk factors for preterm delivery are represented by percentages and counts and are compared between tribal and nontribal women.

We calculated the unadjusted odds ratios for the bivariate analysis followed by an adjusted odds ratio using a logistic regression on the existing data at the KMH to compare sociodemographic variables such as maternal age, tribal status, parity, maternal illiteracy, paternal illiteracy, and marital status; we also

looked at clinical factors such as antenatal care, hemoglobin level, and existence of diagnosed hypertension. All of the odds and adjusted odds ratios were reported with 95% confidence intervals (CIs). The data were exported to STATA version 16 (StataCorp, College Station, TX) for statistical analyses.

Significant variables in the unadjusted analysis were included in the logistic regression. For the adjusted odds ratio, we analyzed tribal or nontribal status while controlling for maternal illiteracy, paternal illiteracy, and marital status; we also looked at clinical factors such as antenatal care, hemoglobin level, and existence of diagnosed hypertension.

Finally, we also considered the neonatal outcomes of preterm deliveries, both for the overall cohort and comparing tribal and nontribal mothers. Outcomes analyzed include live births or stillbirths and status of newborn cry within the preterm live birth cohort.

Results

The total number of deliveries between 2012 and 2019 were 32,557. The description of admission and outcomes are shown in Figure 1. The percentages reported correspond to the denominator in the preceding box in the figure.

Socioeconomic and other relevant characteristics of both tribal and nontribal women who delivered at the hospital are given in Table 1 along with the preterm delivery rate in each category.

Of note is that only a small number (n=16) of mothers were under the age of 18. Because this was the case, for the odds ratio, we analyzed maternal age of ≤25 years. Similarly, a small number (n=21) were unmarried at the time of delivery. Both of these small values are reflective of the surrounding population.

The preterm delivery rate over the study period is given in Figure 2. The total number of preterm deliveries in the study period is 5578. The trend for preterm delivery over the study period shows that the preterm delivery rate among tribal women was consistently higher than the nontribal preterm delivery rate as shown in Figure 2. Overall,

Number of preterm deliveries at the KMH (2012–2019), Bharuch, Gujarat
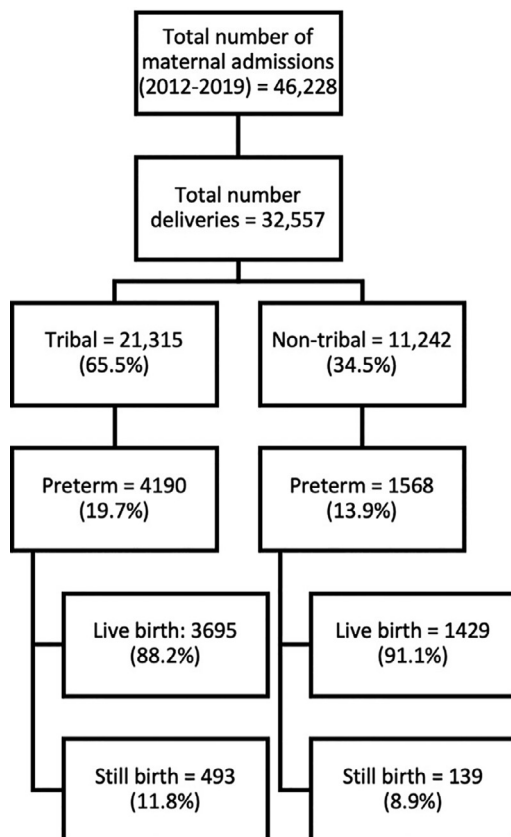
This flowchart shows the overall maternal admissions, deliveries from tribal mothers and nontribal mothers, number of preterm deliveries for each population, and number of live births or stillbirths within the preterm delivery cohort.

KMH, Kasturba Maternity Hospital.

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the tribal preterm delivery rate was 19.7% and the nontribal preterm delivery rate was 13.9%. The analysis of risk factors indicated that tribal mothers have an adjusted odds ratio of 1.16 (95% CI, 1.08–1.24) to deliver preterm after controlling for potential confounders such as maternal illiteracy, paternal illiteracy, anemia (hemoglobin <10 g/dL), hypertension at delivery, and a lack of antenatal care (0 visits to the clinic) as shown in Tables 2 and 3.

The adjusted odds ratio in Table 3, which was calculated using a logistic regression that incorporated all the individual significant risk factors mentioned above, indicates that gestational hypertension in this population did not increase the odds of delivering preterm

when the other variables were included in the analysis, suggesting that there may be confounders. At the KMH, gestational hypertension patients are induced at 37 weeks of gestation or later. The highest adjusted odds ratio of 2.15 was determined for "no antenatal care." Both the unadjusted odds ratios and adjusted odds ratios are displayed in Table 3.

We also analyzed the neonatal outcomes of preterm deliveries in this population, which are depicted in Figure 3 (A and B). The overall stillbirth rate among tribal women is 3.06% and it is 1.73% among nontribal women. When analyzing within the subset of women who delivered preterm in Figure 3A, we see a higher proportion of stillbirth

outcomes among tribal women (11.77%) than among nontribal women (8.86%). In Figure 3B, however, we see similar proportions of neonatal asphyxia in preterm deliveries of tribal women (1.54%) and nontribal women (1.40%).

Discussion
Principal findings
This is 1 of a few studies to quantitatively examine and compare the delivery risk factors between tribal and nontribal women. This study confirms that tribal status, maternal illiteracy, paternal illiteracy, clinical anemia, and lack of antenatal care are all significant independent risk factors for preterm delivery. In addition, adverse neonatal outcomes such as stillbirth or neonatal asphyxia at birth are higher among tribal mothers who delivered preterm than among nontribal mothers.

Results
This study's findings are consistent with those conducted in other regions for significant preterm delivery risk factors. One example of a consistent finding in our study with the existing literature is that of clinical anemia. Low hemoglobin is associated with iron deficiency anemia and is a well-established risk factor for preterm delivery.[18] According to the National Family Health Survey in India, the state of Gujarat has a 60.8% prevalence of anemia among pregnant women, and other studies show a high prevalence of low BMI among young mothers in Gujarat.[19,20] The KMH staff, along with community health workers in the area, counsel pregnant women on nutritional practices during antenatal care visits and provide iron supplements. Both lack of antenatal care and anemia are significant independent risk factors identified in this study.

Clinical implications
Despite the work of organizations such as SEWA Rural that are committed to caring for all populations, it is likely that systemic and structural discrimination may continue to lead to the disparities that our study highlight. The living conditions of tribal populations in India

TABLE 1
Description of all preterm deliveries (demographics)

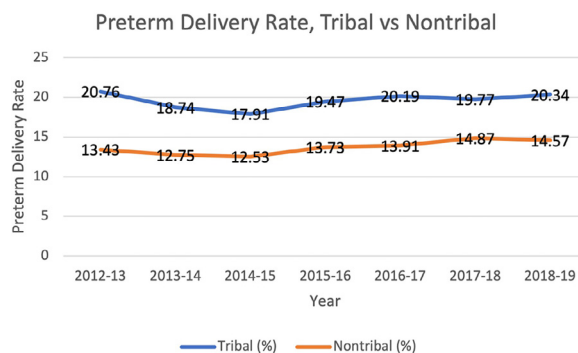| Factor		Tribal preterm deliveries (n=4190)	Nontribal preterm deliveries (n=1568)	Number of preterm deliveries (n, % of overall deliveries)	Total deliveries (N)
Maternal age	≤25 y	3565 (85.08)	1165 (74.30)	4730 (17.85)	26,494
	>25 y	625 (14.92)	403 (25.70)	1028 (16.96)	6063
Religion	Hindu	4163 (99.36)	1342 (85.59)	5012 (16.51)	30,366
	Muslim	0 (0)	222 (14.16)	222 (10.78)	2060
	Missing, Christian, or other	27 (0.64)	4 (0.26)	31 (23.66)	131
Parity	Primigravida	2096 (50.02)	692 (44.13)	2788 (17.55)	15,886
	Multigravida	2094 (49.98)	876 (55.87)	2970 (17.82)	16,662
Maternal education	Illiterate	786 (18.76)	364 (23.21)	1150 (25.01)	4598
	Literate	3404 (81.24)	1204 (76.79)	4608 (16.48)	27,959
Paternal education	Illiterate	655 (15.63)	246 (15.69)	901 (26.00)	3465
	Literate	3535 (84.37)	1322 (84.31)	4857 (16.69)	29,092
Marital status	Married	4179 (99.74)	1566 (99.87)	5745 (17.66)	32,530
	Unmarried	11 (0.26)	2 (0.13)	13 (61.90)	21

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—lack of infrastructure, social determinants, and economic factors—lead to disproportionate health impacts and worse health outcomes among tribal communities.[21,22] Although preterm delivery has been studied in India, and even in pockets of tribal India, the existing findings may not be generalizable to rural areas such as Jhagadia, Gujarat, because of the differences in geography and study design.[23–25] State and local factors, from policy to geography and social barriers, may limit the applicability of the results from different parts of India to Gujarat. For example, the Chiranjeevi program in Gujarat, which started in the Jhagadia district in 2009 to incentivize institutional delivery for the poor, is specific to the area. This insurance scheme encourages women who would normally have given birth at home to seek institutional care and provides incentives to private providers through a financial benefit to provide care, thereby removing any access barriers for the economically disadvantaged patients. The scheme does not focus on improving preterm delivery rates in particular, and there is a lack of data to establish if a relationship exists between the policy and preterm delivery rates. The few studies that looked at the effect of this scheme indicate no impact on maternal health outcomes.[26,27]

Research implications
In addition to confirming existing knowledge of preterm delivery risk factors, this study highlights the role that tribal status may play in influencing delivery outcomes. Given the historic, social, geographic, economic, and political complexity and heterogeneity of tribal populations in India, understanding the risks posed to tribal mothers merits further study.[13] The implications of a multicentered study of multiple tribal populations may lead to meaningful, context-specific data collection, a deeper understanding of the

FIGURE 2
Trend of tribal and nontribal preterm deliveries over study period

This graph shows the preterm delivery rate over the study time period for both tribal and nontribal mothers.

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TABLE 2
Tribal vs nontribal odds ratio for preterm delivery

Community	Deliveries	Preterm deliveries	Unadjusted OR (95% CI)	AOR[a] (95% CI)
Tribal	21,315	4190	1.51 (1.42−1.60)	1.16 (1.08−1.24)
Nontribal	11,242	1568	1.00	1.00

AOR, adjusted odds ratio; *CI*, confidence interval.

[a] Adjusted for other relevant variables.

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TABLE 3
Risk factors of preterm deliveries overall

Risk factor	No.	% of preterm deliveries (preterm N=5758)	Odds ratio (95% CI)	Adjusted odds ratio[a] (95% CI)
Tribal status	4190	72.77	1.51 (1.42−1.60)	1.16 (1.08−1.24)[b]
Maternal illiteracy	1150	19.97	1.69 (1.57−1.82)	1.29 (1.18−1.42)[b]
Paternal illiteracy	901	15.65	1.75 (1.61−1.90)	1.27 (1.15−1.41)[b]
Anemia	2643	45.90	1.61 (1.52−1.70)	1.41 (1.32−1.51)[b]
Hypertension at delivery	673	11.69	1.32 (1.18−1.49)	1.12 (0.98−1.28)
No antenatal care	906	15.73	2.73 (2.51−2.98)	2.15 (1.94−2.37)[b]
Unmarried mothers	13	61.90	7.58 (3.22−17.82)	1.33 (0.65−2.75)

CI, confidence interval.

[a] Adjusted for other relevant variables;; [b] Statistically significant.

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heterogeneity of inequity patterns and of the processes driving these inequities, expansion of resources to focus on healthcare access, and appropriate policy and community-based interventions.

Strengths and limitations
A strength of this analysis is the large number of deliveries over a period of 7 years. Data about a population that is generally understudied and whose healthcare outcomes are not well understood were captured as part of this study.

One limitation of this study is that the variables "tribal" and "nontribal" may bring confounders such as income level and social barriers. "Nontribal" includes Scheduled Caste and Other Backward Castes, and each group brings distinct reasons for economic disadvantage. In the context of this study, we focused on tribal communities because of the barriers of geographic isolation and historically low utilization of institutional healthcare.

Another limitation is the accuracy of gestational dating, especially for those mothers who did not receive antenatal care. When the mother appears for delivery at the hospital, there may or may not be time to do a late term ultrasound to estimate gestational age; however, late term ultrasound dating is not accurate. Therefore, the categorization of term and preterm for mothers who did not receive antenatal care may be inaccurate.

As a retrospective medical record review, we were limited to the data collected by the hospital registry. For example, the rate of home deliveries in this study area is not known, but if significant, it could introduce a potential selection bias because we focused only on hospital-based deliveries. The National Family Health Survey of 2015 to 2016 puts the prevalence of home delivery in India at 22%.[28] There are many variables of interest that we could not analyze because the data were not collected. In an effort to provide a more nuanced picture of what drives preterm deliveries among rural women delivering at the KMH, future studies could be designed as observational or prospective cohort studies to collect additional data of how mothers interact with the healthcare system, their practices and habits during pregnancy, and their clinical profile. These data could include clinical factors such as tobacco use, interpregnancy interval, previous preterm birth, or BMI. Other data may provide better sociodemographic analyses, such as access to sanitary facilities, distance from the hospital, transport cost, interaction with community health workers, nutritional practices, or barriers to care. To provide quality care to this population, we need more organized studies with intentional data collection.

An additional limitation is that this study may not be generalizable, because the data were collected in a single rural community hospital. For example, as mentioned, this study was conducted at a tribal-friendly hospital that utilizes state-specific schemes to encourage institutional delivery and benefits from its long-term presence that includes community-based interactions with tribal women.

Conclusions
Based on this analysis, there is an improved understanding of which pregnancies present a higher risk for preterm delivery among a rural population. Tribal status, maternal illiteracy, paternal illiteracy, clinical anemia, and lack of antenatal care are all significant independent risk factors for preterm delivery. Importantly, this analysis raises more questions than answers.

In conjunction with future studies that provide greater detail, the health system serving a rural population in India could better elucidate the underlying risk factors for pregnant patients and begin to design appropriate community and/or clinical interventions for the prevention of preterm deliveries. ∎

FIGURE 3
Neonatal outcomes of preterm deliveries

Preterm Neonatal Outcomes, 2012-2019: Live vs Still Births

Preterm Neonatal Outcomes, 2012-2019: Respiration
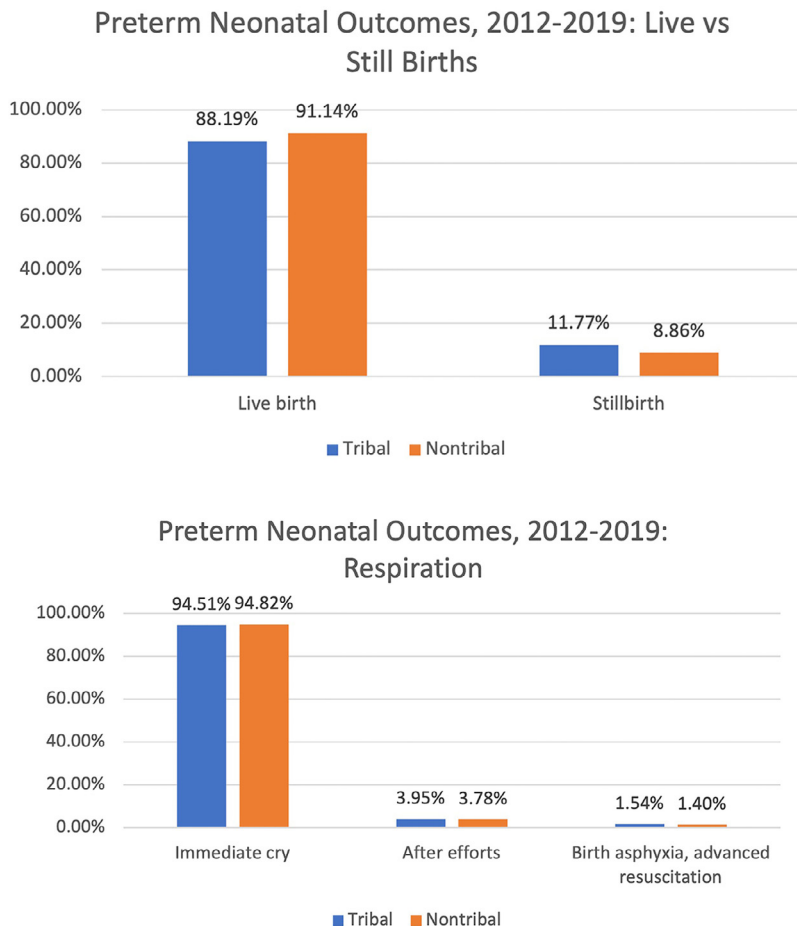
A, live births vs stillbirths: this graph shows the neonatal outcomes within the preterm delivery cohort for tribal and nontribal mothers. **B,** respiration: this graph shows the respiratory neonatal outcomes within preterm deliveries for tribal and nontribal mothers.

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