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Original Research Article

Determinants of birth asphyxia: a cross-sectional multi-centric study in the state of West Bengal

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ABSTRACT

Background: World Health Organization Sustainable Development Goals has set a target of reducing neonatal mortality to less than 12 per 1000 live births by 2030. Birth asphyxia is one of the leading causes of neonatal morbidity and mortality. The purpose of this study was to explore the factors influencing or related to the development of birth asphyxia.

Methods: This was a cross-sectional case control study conducted from March 2024 to March 2025 at three hospitals catering to a population of about five million. Two hundred and two neonates with birth asphyxia were identified and information including demographic, ante-partum and intra-partum variables were collected on a pre-designed questionnaire. Descriptive statistics were used to determine the prevalence of birth asphyxia in cases and controls as per each of the independent variables described above and significance was determined. A bivariate regression was done for those variables which showed significant ($p<0.05$) association and which had shown significance in other related studies.

Results: Bivariate regression analysis showed educational status ($p<0.001$), socio economic status ($p<0.001$), booking status ($p<0.023$), anemia, ($p<0.027$) parity (0.018) and meconium-stained liquor ($p<0.029$) as independent significant variables.

Conclusions: Findings of this study highlight the fact that while medical factors contributing to birth asphyxia have to be addressed there is also need to seriously consider and address the medical care seeking behavior of pregnant women and her family which is influenced by educational and socioeconomic status. The impact of any health welfare scheme would be dependent on this important element.

Keywords: Neonatal morbidity and mortality, Birth asphyxia, Determinants

INTRODUCTION

One of the major objectives of the Sustainable Development Goals of 2030 is to reduce neonatal mortality to less than 12 per 1000 live births.[1] Among the various causes of neonatal mortality birth asphyxia still remains a major cause particularly in developing nations.[2,3]

Asphyxia is a condition where impairment of blood gas exchange, results in hypoxemia (lack of oxygen) and hypercapnia (accumulation of carbon dioxide).[4] A cascade of biochemical changes leads to neuronal cell death, and continuous asphyxia subsequently leads to multiple organ systems malfunction.

Birth asphyxia is the insult to the foetus or newborn due to failure to breathe.[5] As reported by World Health Organization (WHO), worldwide 4 million neonatal deaths occur each year due to birth asphyxia and of those affected 15-20% die in the neonatal period, and up to 25% of survivors have permanent neurological deficits.[3,6] Birth asphyxia accounts for 24 % of all neonatal deaths.[3,7,8] There are several established determinants of acute birth asphyxia which can also be called direct causes. These are

uterine rupture, cord prolapse, placental abruption, and shoulder dystocia. But majority of the other factors are rather chronic in nature and cannot be linked directly to asphyxia. These factors interact with others to either increase or decrease the risk for asphyxia. These could be ante-partum factors like preeclampsia, intrauterine growth restriction, and maternal pyrexia as well as intra-partum factors like the duration of labor or the mode of delivery.

Demographic factors like socioeconomic status, educational status and antenatal care seeking behaviours of would-be mothers, are some other determinants which have a tremendous influence on maternal and foetal outcomes.[9]

In India the neonatal mortality rate still remains high. As per the sample registration system statistical report of 2020 issued by the Registrar General of India the neonatal mortality rate in India is 20 and that in West Bengal is 15. Neonatal deaths in the country contribute to 70% of the total infant deaths.[10]

A number of government schemes are working towards maternal and child welfare and the latest survey has shown a marked increase in utilization of these schemes.[10,11] However, when compared with the Sustainable Development Goals there is yet a long way to go.

This study was done with the aim to find out which particular factors are associated with birth asphyxia in our area in the State of West Bengal and to identify which of these associations are significant. It is a well-known fact that the success and sustainability of a program or project is very context specific. India being a land of diversity where the context, culture, literacy rate, attitudes towards pregnancy and child birth vary from place to place, adopting measures to address these would ensure that health schemes are better able to achieve the Sustainable Developmental Goals.

Objectives

The objectives were to determine the risk factors associated with birth asphyxia in the studied geographical location and to determine the strength of association.

METHODS

Birth asphyxia is defined as inability to establish breathing at birth. As per the WHO classification of diseases ICD 10 for our study, we considered an Apgar of less than 7 at 1 minute as birth asphyxia.[12,13]

Study design and setting

This was a cross-sectional case control study conducted between March 2024 to March 2025 at one tertiary healthcare centre (IQ City Medical College) and two secondary healthcare centres in the city of Durgapur West Bengal. As per the census of 2011 these hospitals cater to a population of about 5 million providing all health care services including prenatal, pregnancy and reproductive health.

Inclusion criteria

Cases

All neonates born after 35 weeks of gestation during the study period and having a one-minute Apgar score of <7 were included in the study were included.

Control

As control 100 neonates born after 35 weeks of gestation with an Apgar score of ≥7 was included for comparison.

Exclusion criteria

Babies with lethal anomalies and babies born before 35 weeks of gestation were excluded.

Study variables

The dependent variable was birth asphyxia. We examined 15 independent variables under 3 categories (Table 1).

Table 1: Dependent and independent study variables.

Variable categories	Independent variable	Dependent variable
Socio-demographic variables	Age	Birth asphyxia
	Educational status	
	Socioeconomic status	
	Booked Case	
Ante-partum variables	Parity	
	Anaemia	
	Pregnancy induced hypertension	
	Hypothyroidism	
	GDM	
	Maternal fever	
Intra-partum variables	Prolonged second stage	
	Mode of delivery	
	Use of oxytocin	
	Use of methods for induction of labour	
	Colour of liquor	

Operational definitions of independent variables

The operational definition of independent variables involves socio-demographic variables.

Occupation involves homemaker or professional and educational status includes as per the 4 classes of the International Standard Classification of Education as given by UNESCO (Table 2).[2]

Table 2: International standard classification of education.

Classification	Education	
0	Pre-primary	Kindergarten and below
1	Primary	1st to 6th class or grade
2	Lower secondary	7th to 9th class or grade
3	Upper secondary	10th to 12th class or grade and higher

Socioeconomic status

As per the modified B. G. Prasad scale applicable for both urban and rural areas depending on one variable: the per capita monthly income of the family (Table 3).[15] For statistical analysis we clubbed lower middle class and lower class into one (lower class) and upper middle class and middle class into one (middle class). Thus, we had three classes upper, middle and lower class.

Table 3: B. G. Prasad scale of socioeconomic status (modified).

Per capita monthly income	Socioeconomic status
>2698	Upper class
1349-2697	Upper middle class
809-1348	Middle class
404-808	Lower middle class
<404	Lower class

Booking status

To consider a case as booked we followed the guidelines for antenatal care and skilled attendance at birth given by national health systems resource centre (NHSRC).[16] The guidelines suggest the following schedule for antenatal visits: 1st visit: within 12 weeks—preferably as soon as pregnancy is suspected—for registration of pregnancy and first antenatal check-up, 2nd visit: between 14 and 26 weeks, 3rd visit: between 28 and 34 weeks and 4th visit: between 36 weeks and term. Pregnant lady having had all these above checkups was considered as a booked case. Ante-partum variables included; anemia: haemoglobin <9 mg/dl, preeclampsia: BP on admission above 140/90 or/and on anti-hypertensives, hypothyroidism TSH level below 3 or/and on thyroxine supplementation, GDM – fasting >95 mg/dl, random >200 mg/dl, 2 hours. Post prandial >140 mg/dl, glycated Hb >6.5%, on medical nutrition therapy (MNT) or oral hypoglycaemic agents (OHAs) or insulin or a combination of any of these.

Maternal fever

Above 37 degrees Celsius or 99-degree Fahrenheit.

Intra-partum variables

Prolonged labour (whether first stage or second) was decided as per the WHO labour guide first stage calculated after 5 cm dilatation till which time labour was considered to be in the latent phase and not included in the calculation of the duration of labor.[17]

Ethical considerations

Ethical clearance was taken from the Ethical Committee of IQ City Medical College and from the of the two secondary care centres under it.

Data collection

Medical interns used a structured data collection form to collect information of the independent variables both in the study population and the controls. The forms were in English and the local language Bengali. Independent variables that were selected for inclusion in the forms were chosen after literature review of articles from various countries.[5,8,18,19] also keeping in mind the documentation protocols of the Departments of Obstetrics and Gynaecology and Paediatrics in the respective hospitals (Table 1).

Data analysis

Data analysis was done using R software. Before the actual analysis the data was coded, and checked for normality. Descriptive statistics were used to determine the prevalence of birth asphyxia in cases and controls as per each of the independent variables described above and significance was determined. A bivariate regression was done for those independent variables which showed significant association and which had shown significance in other related studies. Significance was taken as $p<0.05$.

RESULTS

A total of 4562 pregnant women were admitted. Hundred and thirteen were discharged without delivery. A total of 3426 women delivered during this period. Out of this 3224 were exclude because they had Apgar >7, lethal anomalies or born before 35 weeks A total of 202 cases were included. Out of the healthy babies 100 controls were enlisted. Data was collected for a total of 302 babies (202 with birth asphyxia and 100 controls. Out of the cases 2 had to be excluded because the data was incomplete (Figure 1).

The age distribution of the mothers in the control and case groups was similar and majority of the case were in the age group of 26-35 years (2 taken care).

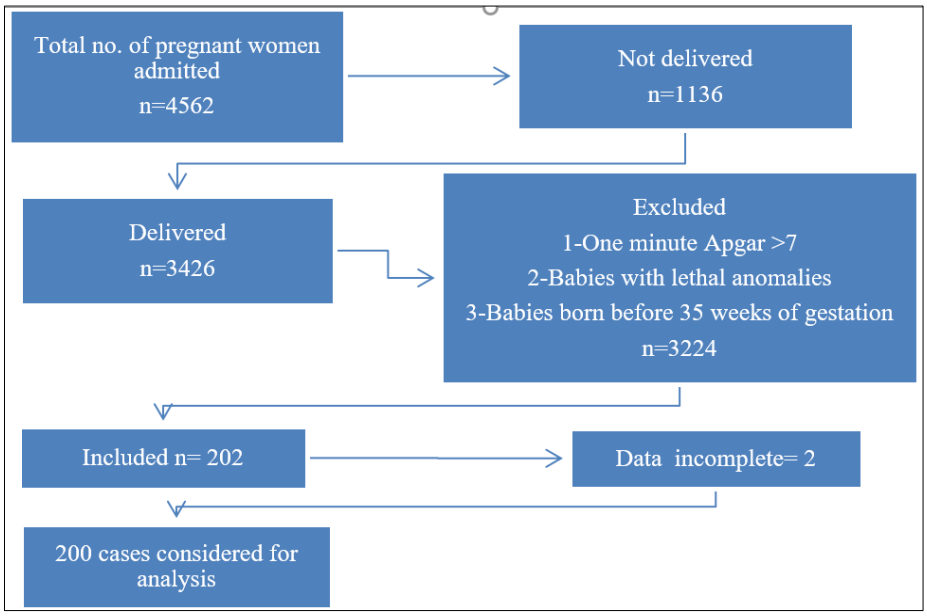

Figure 1: STROBE diagram.

Taken individually the socio-demographic variables of educational status, socioeconomic status and booked or un-booked status were found to be significantly associated with birth asphyxia. Majority of the participants in the case group were illiterate, belonged to a low socioeconomic and an un-booked status. Each of this difference was significant (p<0.001).

Similar association was found with the ante-partum, anaemia and maternal fever. Among the intra-partum factors prolonged labour, mode of delivery and presence of meconium were all significantly associated with birth asphyxia. These associations are illustrated in Figures 2-5.

Ante-partum variables

Majority of the participants in the case group were anemic when compared to the control group and this difference was significant (p<0.001) (Figure 2). Majority of the participants in the case group were febrile when compared to the control group and this difference was significant (p<0.001) (Figure 3).

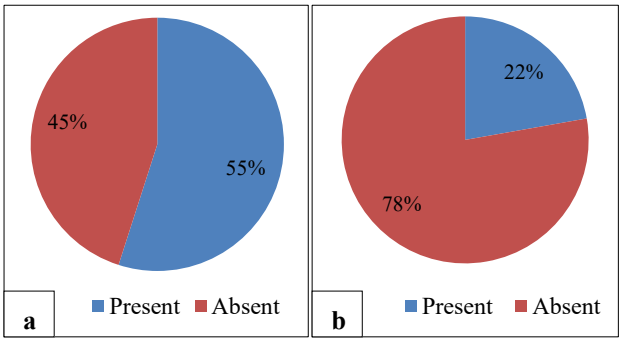

Figure 2: Anaemia status: (a) control versus (b) case groups.

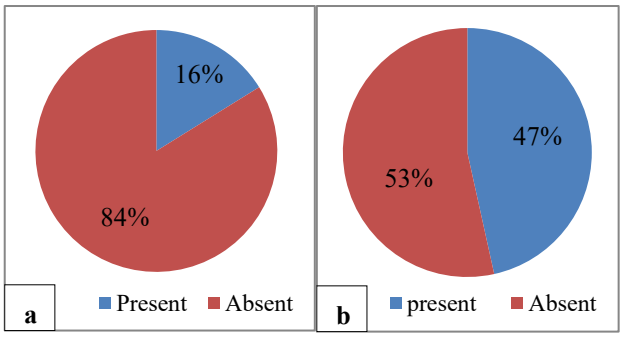

Figure 3: Presence of maternal fever: (a) control versus (b) case.

Intrapartum variables

Majority of the participants in the case group had meconium-stained liquor as compared to the control group and this difference was significant p<0.001 (Figure 4).

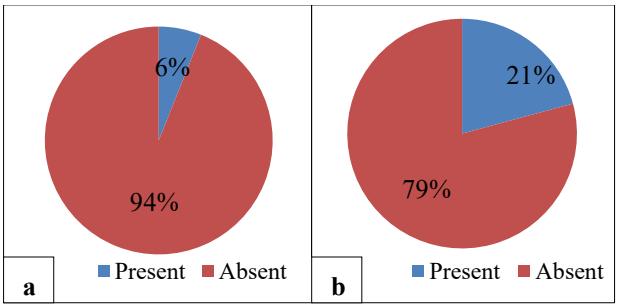

Figure 4: Meconium staining of liquor amniii: (a) control versus (b) case group.

Majority of the participants in the case group had prolonged labor when compared to the control group. This difference was significant (p<0.001) (Figure 5).

A bivariate logistic regression showed socio -economic status, educational status, anaemia, parity and meconium staining as significant variables at 0.05 levels in the logistic regression model. The odds ratio and Wald confidence interval are presented along with the p value (Table 4). The model was not further reduced as the Akaike information criterion (AIC) values had no change on further reduction.[20]

Table 4: Logistic regression model.

Characteristics	OR	Upper 95% CI	Lower 95% CI	P value
Educational status 1 versus 2	0.003	0.000	0.079	<0.001
Educational status 1 versus 3	0.006	0.000	0.083	<0.001
Educational status 1 versus 4	0.023	0.001	0.543	0.019
Socio-economic status 1 versus 2	0.077	0.017	0.348	<0.001
Anemia versus normal	0.178	0.038	0.830	0.027
Meconium-stained versus clear liquor	0.087	0.010	0.780	0.029

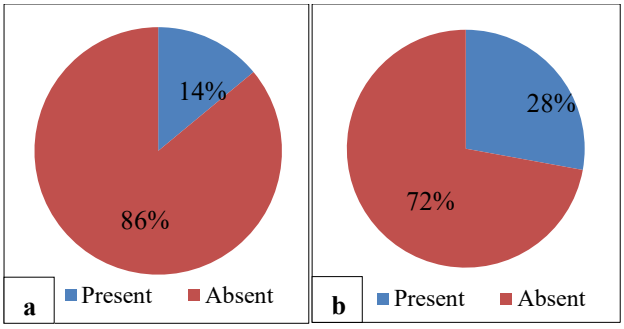

Figure 5: Prolonged labour: (a) control versus (b) case group.

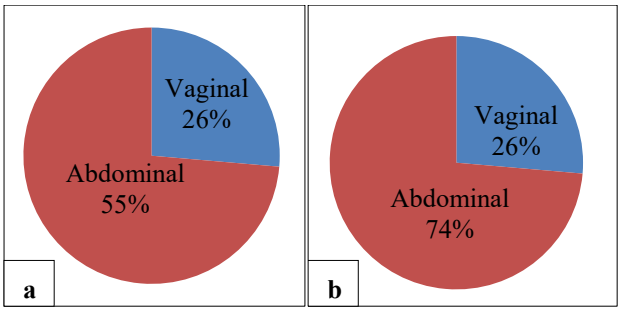

Figure 6: Mode of delivery: (a) control versus (b) case.

DISCUSSION

It is a known fact that medical factors and pregnancy complications would have an adverse effect on maternal, foetal and neonatal well-being. These could be preeclampsia, gestational diabetes, which are pregnancy specific and others like hypothyroidism, asthma, renal disorders that may be associated with pregnancy. Besides these, factors affecting labour would have a profound effect on the health of the new born. Studies conducted in various countries all over the world have proved these facts.[5-9,18-21]

Most of these factors are related to actual medical management of the pregnant women. To take care of these factors' government programs focus on providing adequate health care staff, hospitals and infrastructure.

However, these are not the only factors that would ensure maternal and neonatal health, medical care seeking behaviour of the pregnant women and her family plays a key role because utilizing the benefits of health care schemes is very varied among societies and availability is not equivalent to utilization. A good educational status and knowledge as regards the problems that can happen in an apparently healthy pregnant woman will definitely improve healthcare seeking behaviours. Pregnancy though a physiological state imposes immense burden on every organ of the human body. Good maternal reserves are required so that this physiological state does not turn to disease. Robust antenatal care whether through government or private health schemes is only half the answer. The success of these programs will depend upon the awareness of their existence, acceptance and proper utilization which in turn depends upon the health seeking behaviour of the pregnant women and her family. It is therefore obvious that knowledge and attitude towards maternity care services and their utilization cannot be ignored and maternal and child welfare programs need to take cognizance of this fact. Our study has shown this to be true. The two most significant determinants of birth asphyxia in our study are the educational and the socioeconomic status of the mother which directly influence her health care seeking behaviour. The SRS statistics of India have also given us an insight as to the trends of the medical care seeking behaviour .According to this report in urban and rural India the percentage of live births where mother received medical attention at delivery in either government or private institution was 93.5% and 74.2% in 2015 respectively and rose to 95.0% and 78.2% in 2020.[10] However this report does not elaborate what percentage of these mothers received adequate antenatal care which together with hospital delivery would be a better determinant of health care seeking behaviour of pregnant women.

As regards antenatal care our study has shown a significant association of birth asphyxia with the un-booked status of the mother. Birth asphyxia was significantly more in un-booked cases. A study from Telangana South India has reported that one third of the neonates born to un-booked mothers required resuscitation.[19] Two studies done in

Ethiopia have shown that the number of antenatal visits related inversely with birth asphyxia. The greater the number of visits the lesser was the incidence of birth asphyxia.[8,21]

Another significant factor in our study was the socioeconomic status which had an inverse relationship with birth asphyxia. In India a substantial amount of heath care including maternity services are provided by private hospitals and private practitioners. A financially constrained society would fail to avail these services. Government hospitals and government medical colleges are more often located in urban areas and almost all of these provide free of cost health services but their accessibility may be an important issue.

Among the ante-partum variables parity, anaemia and maternal fever were having the strongest association with birth asphyxia. This association has been found in several other studies as well.[5,6,18,19,21] It would be worth noting that anaemia among women of childbearing is common in most developing countries many of which have ongoing maternal and girl child welfare schemes. This again reflects the importance of health seeking behaviour of the community. Most of these programs focus on distribution of Iron and folic acid tablets, sanitation, menstrual hygiene and knowledge, and emphasis on the health of the girl child. But availability does not necessarily again translate into utilization

In our study apart from anemia other antepartum variables were not significantly associated with birth asphyxia. This may be because there were very few cases of specific pregnancy associated disorders like preeclampsia, gestational diabetes and preexisting medical disorders like asthma and hypothyroidism. It could be said that the study population was homogenous and otherwise healthy. Age wise too there were not too many extremes of ages and about 98% of the mothers were below 35 years of age.

Multi-parity too was found to be significantly associated with birth asphyxia and in our study after a bivariate logistic regression this variable was found to have independent significant association. This is in contrast to some studies which found primi-parity to be strongly associated with birth asphyxia and others which found no association between birth asphyxia and parity.[5,8,18,21-24]

It would be difficult to explain this difference unless we compare birth asphyxia in primi-parous women and multi-parous women with other criteria equalized as has been done in another study where they have done a group analysis which shows different associations between parity and birth asphyxia in different groups.[24]

Among the intra-partum variables mode of delivery, meconium staining and prolonged labour were all significantly associated with birth asphyxia with meconium staining having the strongest individual association. These associations have been established several other studies.[5,8,20-23]

Strengths and limitations

Our study is among the very few studies which focused more on demographic variables because other variables either with effect on pregnancy or pregnancy specific are obviously directly linked with birth asphyxia. Health schemes and welfare programs working with the aim to achieve WHO Sustainable goals could tailor their programs as per the demography of the population that they intend to serve. The control and the comparison groups in the study were similar in their characteristics and therefore the comparison becomes externally valid.

Our study did not have many cases with medical disorders in pregnancy or pregnancy specific disorders either in the control or the comparison groups. This may be considered both as a strength or a limitation. Strength because it represented a homogenous population where the importance of demographic factors was brought forth and limitation because the interaction between demographic variables and pregnancy specific variables could not be studied.

CONCLUSION

Neonatal morbidity and mortality are still significant problems all over the world and have far reaching effects with birth asphyxia as a major contributor. While medical factors contributing to birth asphyxia have to be addressed there is also need to seriously consider and address the medical care seeking behaviour of pregnant women and her family in particular and the society as a whole. The success and failure of any health welfare scheme would be dependent on this one important element.

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