Predictors of Birth Asphyxia among Neonates in Dodoma Region Tanzania: A matched case-control study

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Abstract

INTRODUCTION

There has been an increase in the morbidity and mortality rates among neonates born with Birth Asphyxia (BA) in Africa including Tanzania. Despite the efforts made by the stakeholders the problem of BA is still persistently increasing. The study aimed at determining the predictors of BA among neonates in the Dodoma region of Tanzania.

MATERIALS AND METHODS

This study employed a matched case-control study design and was conducted between May-August 2021. A total of 317 neonates were recruited in the study. Data were collected by using questionnaires whereby information related to maternal and neonatal characteristics was collected. The association between variables was determined using the Chi-square test and logistic regression.

RESULTS

Among the cases, the majority were females (68.36%) and 31.64% in the controls. Odds of developing BA were 3 times among neonates with meconium stains (AOR=3.731, C I [1.764,7.937]. p=0.0006), and 2 times among neonates with a birth weight of 2500-3999 (AOR =2.127, [1.110,4.078], p=0.0230) while not having complications during pregnancy was a protective factor (AOR= 0.326[0.171,0.624], p=0.0007).

CONCLUSION

Membrane rupture and birth weight were positively associated with BA and having no complications was negatively associated with BA.

***Keywords**: Birth Asphyxia, Predictors, Neonates*

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Introduction

There has been an increase in the morbidity and mortality rate among neonates born with Birth Asphyxia (BA) in Africa including Tanzania(1). It is defined as the failure to initiate and sustain normal breathing at birth, Birth asphyxia is a persistent problem in low and middle-income countries (2).

Globally, 2.5 million neonates died in 2018, whereby approximately 7000 newborns die every day (3). Approximately 24% of all neonatal deaths are attributed to BA (4,5). In 2018, Sub-Saharan Africa had high neonatal mortalities due to BA with 28 death per 1000 live birth (3). According to UNICEF and WHO, the proportion of neonatal death in Africa due to BA in 2018 was 31% (6,7).

In Tanzania, the mortality rate accounts for 32 death per 1000 live birth and 68 per 1000 live birth for infants, the main cause was (pneumonia 29%, birth asphyxia 27% and preterm birth 23%)(8). Comprehensive intervention in neonatal resuscitation including appropriate and timely Helping Baby Breathing (HBB) training, Basic Emergency Obstetric Care (BEmOC), and Comprehensive Emergency Obstetric Care (CEmOC) reduced the burden of mortality and morbidity by 47% and 24% for fresh stillbirth (9).

In the stride forward to reaching universal health coverage, the Sustainable Development Goals (SDGs) target the reduction of preventable neonatal mortality by 2030 worldwide. SDG goal number 3.2 aims at reducing neonatal mortality to as low as 12 per 1,000 live births in every country (10,11).

Existing evidence attests to the fact that morbidity and mortality due to BA are preventable for about 30% and treatable by comprehensive health care services (12). BA can be prevented by proper management of the mother during the perinatal period. Correct use of the Apgar score for resuscitation by skilled staff could save neonatal life (12–16). BA is not just a medical diagnosis, but also a nursing and midwifery concern, as the standard neonatal care after birth is prompt drying, stimulation, and warmth, which is a sufficient intervention to initiate and maintain breathing for 99% of neonates (17,18).

Despite the efforts such as timely Helping Baby Breathing (HBB) Basic Emergency Obstetric Care (BEmOC) and Comprehensive Emergency Obstetric Care (CEmOC) made by the stakeholders to overcome the chis challenge (9), neonatal morbidity and mortality persist due to BA. The problem is more pronounced in Tanzanian settings and several factors have been implicated in this growing problem. However, there is a scarcity of recent studies that have studied the factors associated with this increasing trend. For this reason, this study was conceptualized to identify specific predictors for BA in the Dodoma region of Tanzania. The specific objective of this study was to assess predictors of BA in the Dodoma region.

Materials and methods

Study design and setting

A Matched case-control study design was applied to complete this study. This study was conducted in public health facilities of different levels in the Dodoma region of Tanzania. In this study, a total of 11 health facilities including Dodoma Regional Referral Hospitals (DRRH), Benjamin Mkapa Hospital (BMH), St Gema, Kongwa and Bahi Districts Hospitals, Makole, Hombolo, Mundemu, Ugogoni, Mlali and Bahi Health Centres were included in the study.

Dodoma Region is among the 34 regions of Tanzania. It is located in the central part of Tanzania at 6˚10′2 S 35˚44′31′′E / 6.17306˚S 35.74194˚E coordinate: 6˚10′23S′′ 35˚443′1′′E / 6.17306˚S 35.74194˚E. Dodoma is the capital city located in the Central Zone of Tanzania with 413,110 hectares or 2.5%. The mainland area is about 885,987 square km. Dodoma town is 486 km (320 mi) west of the previous capital city Dar es Salaam and 441 km (274 mi) south of Arusha, the headquarters of the EAC. It covers an area of 2,669 square kilometres (1.031 sqm) of which 625 square kilometres (241sq mi) are urbanized. Dodoma region is bounded by Manyara in the north, Singida to the West, Morogoro to the South East and Iringa in the south. The region is distributed into seven districts (Kondoa, Chemba, Bahi, Dodoma, Chamwino, Kongwa and Mpwapwa, 8 local government authorities, 29 divisions, 209 wards, 607 villages, 181 streets, and 2,184 hamlets. Currently, Kondoa comprises Kondoa Town Council and Kondoa District Council. Dodoma RRH serves as a referral centre for all its districts and councils It also serves

patients/ clients from neighbouring districts and regions (Gairo in Morogoro, Kiteto in Manyara and Manyoni in Singida). The region has 9 district hospitals, 30 health centres and 284 dispensaries

Population

The list of neonates who were selected for cases and controls had the same birth weight and gestational age. Each case was matched with two controls born in the same period. Matching was done using the register book at the maternity unit. This was aimed at identifying the next suitable birth category from the same study area with the same category. Those who had delivered and were residing in the study site during the study period were included. Excluded neonates were those with anaesthesia-related low Apgar score, severe congenital abnormality, metabolic disorders and neonates with parents who did not wish to participate in the study.

Sample size and Sampling technique

The sample size was calculated by using the formula (19)**,** which is suitable for matched case-control studies. The proportion of cases and controls was based on the study which was conducted in Zambia by Halloran and colleagues (20), for the matched case-control study using the following assumptions: 95% confidence level, power 80%, the matching criteria of 2:1 controls to cases ratio. The minimum sample size was 317 neonates, 216 controls and 101 with a ratio of 2.1, simple random sampling was utilised for the selection of controls and convenience sampling was applied to include all cases in the study.

Data collection and assessment

Data were collected using an interviewer-administered questionnaire, and documentary review. The researchers administered questionnaires, asking mothers, and filling out the questionnaires. This was conducted in the post-natal ward. The documentary review was used to obtain information on maternal comorbidity, number of ANC visits and gestational age. Two days of training were conducted for all data collectors including nurses in the post-natal ward. The training aimed to orient nurses to ensure an accurate diagnosis of BA, and how to best score the Apgar score chart.

A structured questionnaire was adopted from ((21,22) and from the Tanzania HIV/AIDS and Malaria indicator survey 2011-2012. The tool consists of 78 items: 40 items to assess the socio-demographic factors, 20 items to assess maternal factors and 18 items to assess neonatal characteristics. The tool indicated a Cronbach's Alpha of 0.81.

Variables

The independent variables included in this were socio-demographic characteristics such as maternal and neonatal-related factors. Mothers' age, level of education, marital status, monthly income, religion and family size. Gravidity, gestation, ANC visits, danger symptoms, maternal comorbid conditions, premature rupture of membrane, UTI, bad obstetric history, sex of a child, gestational age and birth weight. Others were complications during labour and delivery, ruptured membrane, amniotic fluid status, doing any work in the last 12 months, occupation and tribe. The dependent variable in this study is BA.

Data analysis

Basic descriptive statistics such as frequency and per cent were used to describe the characteristics of the surveyed neonates and a Chi-test square for assessing the relationship between BA and several categorical characteristics was performed. A binary logistic regression model was used to determine the factors associated with BA among neonates where odds ratio and 95% confidence interval were reported, SPSS version 25 was used for data analysis and the significance of all statistical tests was determined at a 95% level.

Ethical considerations

Ethical clearance was obtained (Ref no MA.84/261/02/35) from the University of Dodoma Ethical and Publication Committee. Necessary permissions were given. On the days of data collection, the nature and the purpose of the study were briefed to the participants, informed written consent was obtained, and confidentiality and anonymity were observed. Approval from the ethics committee was obtained on 11th February 2021.

Results

Demographic characteristics

In total, 317 mothers were included in the study with a 100% response rate, 101 cases and 216 controls. The mean age of the mothers was 26.59, SD 6.63 years and the mean birth weight was 3.227 (SD: 0.55). More than half (70.55% of the controls and 29.25% of the cases had primary education.

Regarding marriage, (67.59%) of the control and 32.41% of cases were married. More than half (72.68%) of controls and 27.32% of cases were doing any job in the last 12 months. Regarding the sex of the children, the majority of the respondents (31.64%) of the cases and 68.36% of the controls were female babies while 32.61% of the cases and 67.39% of the controls were male babies.

The majority of the neonates (36.14%) of the cases and 63.86% of the controls had body weights of 2500-3999 while 24.35% of the cases and 75.65% of the controls had body weights of 4000 and above. (Table 1).

Table 1:
Demographic Characteristics of the Study Participants (N=)

	Variable	Cases n (%)	Controls n (%)
Age	≤25	53(32.12)	112(67.88)
	26-35	38(31.93)	81(68.07)
	≥35	10(30.30)	23(69.70)
Education level	Not attended	24(37.50)	40(62.50)
	Primary school	43(29.45)	103(70.55)
	Secondary school	26(33.33)	52(66.67)
	Above secondary	8(27.59)	21(72.41)
Occupation	Farmer	33(26.40)	92(73.60)
	Formal job	68(35.42)	124(64.58)
Marital status	Married	94(32.41)	196(67.59)
	Single	7(25.93)	20(74.07)
Doing any work in the last 12 months	Yes	53(27.32)	141(72.68)
	No	43(42.57)	58(57.43)
Tribe	Gogo	56(35.00)	104(65.00)
	Rangi or chaga	12(20.00)	48(80.00)
	Others	33(34.04)	64(65.98)
Religion	Christian	84(33.87)	164(66.13)
	Muslim	17(24.64)	52(75.36)
Sharing toilet with other households	Yes	54(41.54)	76(58.46)
	No	43(26.38)	120(73.62)
Sex of a child	Male	45(32.61)	93(67.39)
	Female	56(31.64)	121(68.36)
Birth weight of a child	<2500-3999	73(36.14)	129(63.86)
	≥4000	28(24.35)	87(75.65)

Maternal factors

Table 2 provides details on the maternal factors predicting birth asphyxia. Looking at the gestation age, 34.22% of the cases and 65.78%) of controls were full term and in 26.32% of cases, 28 (73.68%) of the controls were nearly term. Among 32.35 cases and 46 67.65% of) control had adverse birth effects while 31.73% of cases and 68.27% of the control group had no adverse birth effects. The status of the amniotic fluid was clear for 2.63% of the cases and 77.37% of the controls.

Stained meconium was observed in 62.16% of the cases and 55.88% of the controls. Complications during labour were observed among 51.43% of the cases and 48.58% of the controls while 22.17% of the cases and 77.83% of the controls had no complications during labour.

Factors associated with BA

Initially, Chi-square was performed, which showed a significant association in maternal age (x2 =0.0432, p value= 0.9791), sex of a child (x 2 = 0.0335, p-value = 0.9034) and history of adverse birth outcome (x 2 =0.0096, p value= 1.0000).

There was no significant association between BA with education level, occupation, marital status, tribe, religion, ANC attendance, medical problems, the status of amniotic fluid and complications during labour. Therefore, we entered into the logistic regression model, which showed that BA was significantly predicted by sharing toilet facility with other households [OR=1.983; 95%, CI 1.211, 3.246, p=0.0134], the status of amniotic fluid (p=0.0006), birth weight of a child [OR= 5.618; 95%, CI 1.764, 8.130, p=0.0230], having complications during labour [OR= 0.269; 95%, CI 0.163, 0.444, p=0.0007].

Table 2:
Maternal factors influencing birth asphyxia

	Variable	Cases n (%)	Controls n (%)
Gestational age	Below 36 Nearly term	10(26.32)	28(73.68)
	37-42 Term	90(34.22)	173(65.78)
	42 and above post term	0(0.00)	8(100.00)
History of adverse birth outcomes before this pregnancy	Yes	22(32.35)	46(67.65)
	No	79(31.73)	170(68.27)
Mode of delivery	SVD	67(28.03)	172(71.97)
	C-section	30(44.12)	38(55.88)
Status of amniotic	Clear	55(22.63)	188(77.37)
	Stained Meconium	46(62.16)	28(37.84)
Complications during labour	Yes	54(51.43)	51(48.57)
	No	47(22.17)	165(77.83)
Visiting facility for ANC follow-up only	Yes	68(32.38)	142(67.62)
	No	16(31.37)	35(68.63)
The spacing between this child and the previous one	One year	6(42.86)	8(57.14)
	Two years	15(35.71)	27(64.29)
	Three years	20(31.25)	44(68.75)
	More than3 years	15(24.59)	46(75.41)
Dangerous symptoms during ANC visit?	Yes	30(42.86)	40(57.14)
	No	67(30.04)	156(69.96)

Table 3:
Factors associated with birth asphyxia among controls and cases

	Variable	Controls N (%)	Cases N (%)	Chi-square	p-value
Age	≤25	112(67.88)	53(32.12)	0.0423	0.9791
	26-35	81(68.07)	38(31.93)		
	≥35	23(69.70)	10(30.30)		
Education level	Not attended	40(62.50)	24(37.50)	1.6496	0.6482
	Primary school	103(70.55)	43(29.45)		
	Secondary school	52(66.67)	26(33.33)		
	Above secondary	21(72.41)	8(27.59)		
Occupation	Farmer	92(73.60)	33(26.40)	2.8352	0.9998
	Formal job	124(64.58)	68(35.42)		
Marital status	Married	196(67.59)	94(32.41)	0.4789	0.6662
	Single	20(74.07)	7(25.93)		
Work in the last 12 months	Yes	145(72.50)	55(27.50)	7.0409	0.0090
	No	60(58.25)	43(41.75)		
Tribe	Gogo	104(65.00)	56(35.00)	4.8227	0.0897
	Rangi or chaga	48(80.00)	12(20.00)		
	Others	64(65.98)	33(34.04)		
Religion	Christian	164(66.13)	84(33.87)	2.1198	0.9998
	Muslim	52(75.36)	17(24.64)		
Sharing toilet facility with other households	Yes	76(58.46)	54(41.54)	7.5034	0.0085
	No	120(73.62)	43(26.38)		
Sex of a child	Male	93(67.39)	45(32.61)	0.0335	0.9034
	Female	121(68.36)	56(31.64)		
Place you attended ANC	Dispensary	104(65.00)	56(35.00)	1.8800	0.3906
	Health centre	83(72.81)	31(27.19)		
	other	29(67.44)	14(32.56)		
Trimester of pregnancy did you start attending ANC, during the first ACN visit	First trimester	83(64.84)	45(35.16)	1.0737	0.3267
	Second or third	133(70.37)	56(29.63)	0.7783	0.3773
Medical problems in the last months related to this pregnancy	Yes	42(63.64)	24(36.36)		
	No	174(69.32)	77(30.68)		
Adverse birth outcomes before this pregnancy	Yes	46(67.65)	22(32.35)	0.0096	1.0000
	No	170(68.27)	79(31.73)		
Mode of delivery	SVD	172(71.97)	67(28.03)	6.3365	0.0175
	C-section	38(55.88)	30(44.12)		
Status of amniotic	Clear	188(77.37)	55(22.63)	40.8264	<.0001
	Stained Meconium	28(37.84)	46(62.16)		
Birth weight of a child	<3000	129(63.86)	73(36.14)	4.6927	0.0334
	≥3000	87(75.65)	28(24.35)		
Complications during labour	Yes	51(48.57)	54(51.43)	27.6899	<.0001
	No	165(77.83)	47(22.17)		

In multiple logistic regression sharing toilets facility with pregnant mothers was more likely two times to deliver a neonate with BA as opposed to those who did not share their toilets with another household [AOR =2.183, 95%, CI 1.176, 4.053, p value= 0.0134].

Mothers with stained meconium were three times more likely to have neonates with BA as opposed to those with clear meconium [AOR =3.731, 95%, CI 1.764, 7.937, p-value = 0.0230]. The normal birth weight category was more likely two times to have BA [AOR= 2.127, 95%, CI 1.110, 4.078, p=0.0230). More details are given in Table 4.

Discussion

This study was conducted to identify predictors of birth asphyxia in the Dodoma region of Tanzania. Maternal age, level of education of mother, occupation, sharing toilet, sex of the child, previous adverse birth outcome, mode of delivery, the status of amniotic fluid, complications during pregnancy, labour and delivery were found to be the predictors of BA

Table 4:
Association of Birth Asphyxia and Several Predictors

Variable	Controls	Cases	Unadjusted analysis		Adjusted analysis	
	N (%)	N (%)	OR [95%CI]	P-value	AOR [95%CI]	p-value
Occupation				0.0932		0.7654
Farmer	92(73.60)	33(26.40)	Reference		Reference	
Formal job	124(64.58)	68(35.42)	1.529[0.931,2.509]		1.109[0.562,2.188]	
No	60(58.25)	43(41.75)	Reference		Reference	
Tribe				0.0966		0.3795
Gogo	104(65.00)	56(35.00)	Reference		Reference	
Rangi or Chaga	48(80.00)	12(20.00)	0.464[0.228,0.945]	0.0345	0.513[0.196,0.342]	0.1736
Others	64(65.98)	33(34.04)	0.958[0.563,1.629]	0.8729	0.940[0.465,1.904]	0.8646
Religion				0.1476		0.2844
Christian	164(66.13)	84(33.87)	Reference		Reference	
Muslim	52(75.36)	17(24.64)	0.638[0.348,1.172]		0.645[0.290,1.439]	
Sharing toilet facility with other households				0.0065		0.0134
Yes	76(58.46)	54(41.54)	1.983[1.211,3.246]		2.183[1.176,4.053]	
No	120(73.62)	43(26.38)	Reference		Reference	
Mode of delivery				0.0127		0.1295
SVD	172(71.97)	67(28.03)	Reference		Reference	
C-section	38(55.88)	30(44.12)	2.028[1.163,3.534]		1.779[0.845,3.745]	
Status of amniotic fluid				<.0001		0.0006
Clear	188(77.37)	55(22.63)	Reference		Reference	
Meconium stained	28(37.84)	46(62.16)	5.618[1.764,8.130]		3.731[1.764,7.937]	
Birth weight of a child				0.0313		0.0230
< 2500-3999	129(63.86)	73(36.14)	1.758[1.052,2.938]		2.127[1.110,4.078]	
≥4000	87(75.65)	28(24.35)	Reference		Reference	
Any complications during labour				<.0001		0.0007
Yes	51(48.57)	54(51.43)	Reference		Reference	
No	165(77.83)	47(22.17)	0.269[0.163,0.444]		0.326[0.171,0.624]	

The findings that sharing a toilet with other households (p= 0.0134), the status of amniotic fluid (p=<.000001, birth (p= 0.0230), weight and complication during (p=0.007) were significantly associated with BA are also reported by previous studies in other lower and middle-income countries such as India, Ethiopia, Nigeria, and Rwanda (Ilahetal., 2015(21,23). In India, for example, a study revealed that 20% of the women who shared toilets underwent adverse pregnancy outcomes such as BA (24). Furthermore, it was noted that maternal age ≤25 was significantly associated with BA (p=0.0423)(25).

The employment status or occupation, tribe, religion, education level and mode of delivery in this study were not significantly associated with BA. These findings contradict the study conducted in Thailand and Ethiopia where employment status (p=0.0180) and educational level, were significantly associated with BA. The odds ratio of literacy which were 6 times higher as opposed to those who were educated above diploma [AOR = 6; 95% CI (1.51, 23.80)] (26,27). This is because intervention strategies like employment opportunities for Tanzanians and increasing health service contacts for mothers are likely to improve neonatal outcomes. Also, the empowerment of women and increasing female education could improve child survival in Tanzania (28).

Strengths and limitation

This study sampled cases and controls; cases were admitted to NICU. This may not be a true representation of the BA prevalence at the community level. There was missing data from records on a few variables of interest like ethnicity, alcoholic drinking, and cigarette smoking were not recorded. Maternal files with missing records were not included in the study.

Conclusion

Birth asphyxia was diagnosed in 101 out of 316 neonates from 11 hospitals. This finding portrays that the rate of BA is high in the study area. Birth Asphyxia was significantly associated with sharing toilet facilities with other households, the status of amniotic fluid and the birth weight of a child, while having no complications during pregnancy and labour was regarded as a protective factor because it has a negative association with BA. Trained healthcare professionals could do more to lower the BA rate and predictors in Tanzania.

Recommendations

We recommend that similar studies investigating predictors of BA should be conducted. Studies on the experiences of family members with asphyxiated neonates could also help demystify the problem.

Healthcare providers need to inform the communities, especially mothers, about the danger signs of BA. Better access to appropriate health care for women and newborns when problems are detected is also needed. The study reinforces the need for more focus on neonatal care during antenatal care, care immediately or shortly after delivery.

Midwives and doctors have a role to play in developing knowledge and skills about health for both mothers and neonates. Maternal and neonatal health care providers should consider comprehensive intervention for early detection of obstetric complications through close follow-up of pregnant mothers, and earlier detection of maternal complications.

Earlier detection of abnormalities should allow immediate decisions for emergency obstetrics and neonatal care interventions. Proper use of the Apgar score and timing could save the life of the child. Moreover, to make a diagnosis of BA by using only the APGAR score was considered due to the lack of facilities for umbilical cord blood Ph and arterial blood gas analyses in low-income countries (29).

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Declaration of study subjects' consent

The authors certify that they obtained all appropriate patient consent forms. In the form, the study subjects gave their consent for their medical information to be reported in the journal. The study subjects understood that their names and initials would not be published and due efforts were made to hide their identity.

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Conflicts of interest

There are no conflicts of interest

Author contribution

HMG, SK, and SA conceptualized the study and organized data collection. HMG and AK wrote the first draft of the manuscript. HMG and SK ran the analyses and wrote the results section. SM and SA contributed to the revision of the final version of the manuscript.

Competing interest

The authors declare that there are no competing interests.

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