Original Article

Influence of Route and Location of Delivery on Neurodevelopmental Sequelae among Infants who Suffered Birth Asphyxia

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Abstract

Aim: This study aims to examine the influence of route and location of delivery on Neurodevelepmental Sequelae (NDS) among infants who suffered birth asphyxia. **Materials and Methods:** This was a cross-sectional study conducted from January 2018 to May 2019. A total of 271 infants diagnosed with birth asphyxia with a gestational age between 38 and 42 weeks were included. NDS was assessed using a structured datasheet. A 3 × 2 contingency table was employed to compare the prevalence between route, location of delivery, and weight. Spearman's rho correlation and binary logistic regression were used to establish the relationship between the NDS and predictor variables. **Results:** The result indicated that route (14.4%) and location (14.4%) of delivery have accounted much for the point prevalence of NDS than weight (7.5%). In addition, route, location of delivery, and weight were also positively related to NDS ($P < 0.05$). The significant predictors explained about 67.4% of the variability in the NDS (Nagelkerke R Square = 0.674). Further, those who have had cesarean section have fewer odds of developing NDS (0.035, 95% confidence interval [CI], −0.239, 0.309) and those who had less weight have much odds of developing NDS (0.811, 95% CI, 0.791, 0.831). **Conclusion:** Route and location of delivery influenced asphyxiated infants to develop NDS. However, cesarean section and hospital delivery confer much more protection against NDS.

Keywords: Birth asphyxia, cesarean section, home delivery, hospital delivery, neurodevelopmental sequelae, vaginal delivery

Introduction

Birth asphyxia defined as the incapacity to start or maintain continuous breathing by the neonate has been a global challenge.[1] Given that the condition has a very high morbidity rate, its management has been very challenging particularly in the poor health setting.[2] Birth asphyxia has been reported as the major cause of neonatal death worldwide.[3-5]

The death rate due to birth asphyxia soars more commonly in middle-income and less-resourced nations where health-care facilities and personnel are inadequate,[6,7] and more than half of the deliveries occur at home.[8] However, according to the world health statistics, there has been tremendous improvement in minimizing newborn death due to birth asphyxia globally, with the worldwide death rate of children <5 years of age declining from 93/1000 live births to 41/1000 live births in 1990 and 2016, respectively.[9,10] This outcome indicates that effective measures to prevent birth asphyxia globally are coming into effect particularly in the advanced nations where people have adequate access to medical facilities.[9]

Despite advances in health care globally, poorly-resourced nations are still at large regarding good quality medical care and this has resulted in so many life-threatening events including birth asphyxia. In addition, data concerning birth asphyxia and its relationship to neurological sequelae among

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infants are rarely reported in Sub-Saharan Africa where the majority of deliveries occur at home. In this current study, we have examined the influence of route (vaginal delivery [VD] and cesarean section), location of delivery (hospital delivery and home delivery), and weight on neurodevelopmental sequelae (NDS) of neonates who were traumatized by birth asphyxia.

Materials and Methods

Study design

This was a cross-sectional study conducted to evaluate the influence of route and location of delivery on NDS of infants who have suffered birth asphyxia.

Ethical approval

The appropriate institutional review boards approved the study while parents of the neonates signed informed consent.

Research setting

This research was a bi-center study conducted at Murtala Mohammed Specialist Hospital (MMSH) and Hasiya Bayero Pediatrics Hospital (HBPH), Kano State Nigeria. The MMSH and HBPH are tertiary hospitals with above 500 and 200 beds, respectively.[11]

Sample size consideration

The sample was estimated following the principles and assumptions of regression analyses.[12-14] This formula (×40 *m*), was used for the calculation, where *m* is the number of variables in the model. In this current study, five predictor variables were identified as the variables that were correlated positively with the outcome variable (NDS). Based on this assumption, the sample size was, therefore, calculated as (40 × 5 = 200). The sample size was then increased to 271 to support and strengthen the model.

Study participants

A convenience sampling technique was used to recruit 271 infants who were diagnosed with birth asphyxia admitted to the MMSH and HBPH neonatal intensive care units with gestational age between 38 and 42 weeks from January 2018 to May 2019. Inclusion criteria required infants who were admitted within <24 h of age with a clinical past of birth asphyxia, 5 min Apgar score of <7, history of not crying early and/or requiring resuscitation for >10 min. Infants not meeting the above criteria or those with other anomalies were excluded from the study.

Study instrument for data collection

A standardized form was used to collect data in this study. Infants' demographic characteristics such as date of birth, weight, and sex were then obtained. Birth history comprises location (home or hospital) and route of delivery (vaginal or cesarean section), and Apgar scores (1, 5, and 10 min). Participants were diagnosed clinically with birth asphyxia at the first examination by a pediatrician as per birth history or Apgar scores.[15] Neonates' growths were classified using the Denver Developmental Screening Tool-2,[16] and asphyxia was categorized as present or absent.[17] Neurologic evaluations were performed by two experienced Neuro-physiotherapists.

Statistical analysis procedure

Descriptive statistics of frequencies and percentages were used to summarize the demographic clinical parameters of the participants. Besides, the point of the prevalence of NDS among the infants was computed using percentages. A 3 × 2 contingency table was employed to compare the prevalence among the three variables (route, location of delivery, and weight). Spearman's rho correlation was used to determine the relationship between the NDS and the predictor variables. Multicollinearity check was performed to examine the correlation among the predictor variables and thereafter, binary logistic regression was employed to determine variables' predictability. A step-by-step analysis was carried out and model improvement with the addition of each predictor variable, percentage accuracy of each model, *P* value, and standard error and odds ratios were used in assessing the models. Furthermore, model fitness to the data was obtained in the form of Nagalkerke R square. A model with the highest overall percentage correctness which was said to be reliable and at the same time fit the data was then be chosen. SPSS software (version 20.0) was used to analyze the data, with *P* at 5% and confidence interval (CI) at 95%.

Results

A total of 271 children (aged 3 months to 2 years) participated in the study [Table 1]. The distribution of patients with NDS was presented in Table 2. The prevalence of NDS due to the influence of the independent variables is presented in Table 3. The result indicated that the route and location of delivery have accounted much for the point prevalence of NDS in patients who suffered birth asphyxia. The relationship between the NDS and predictor variables is presented in Table 4. The result indicated that infants' weight, CS, and HD, were all negatively related to NDS ($P = 0.000$). However, HD and VD were positively related to NDS ($P = 0.000$). Other variables such as age ($P = 0.578$), and gender ($P = 0.676$) were not related. The collinearity results among the predictor variables are presented in Table 5. The variance inflation factor for each variable was <4 indicating that there was no significant collinearity among variables. The influences of the independent variables on the NDS are presented in Table 6. The significant predictors explained 67.4% of the variability in the dependent variable (Nagelkerke R Square = 0.674 [Table 6]). Besides, the outcome also indicated that those who have had cesarean section have fewer odds of developing NDS (0.035, 95% CI,−0.239, 0.309) and those who had less weight have much odds of developing NDS (0.811, 95% CI, 0.791, 0.831) [Table 5].

Results summary based on the odds ratios:

1. CS accounted for 3.5% odds of having NDS. This means that exposure to CS confers protection against NDS by largely 96.5%

Table 1: Demographic characteristic of the participants

Variable	*n* (%)
Age group (months)	
3	25 (9.2)
6	31 (11.4)
9	48 (17.7)
12	36 (13.3)
15	40 (14.8)
18	32 (11.8)
21	30 (11.1)
24	29 (10.7)
Total	271
Sex	
Male	156 (57.6)
Female	115 (42.4)
Mode of delivery	
Vaginal	205 (75.6)
CS	66 (24.4)
Place of delivery	
Home	113 (41.7)
Hospital	158 (58.3)

CS: Cesarean section

Table 2: Distribution of patients with neurodevelopmental sequelae

	n (%)
Hearing	10 (15.5)
Vision	7 (10.6)
Language	18 (27.3)
Gross motor	33 (50)
Fine motor	27 (40.9)
Tone	49 (74.2)
Reflexes	25 (37.9)

Table 3: Point prevalence of neurodevelopmental sequelae due to the influence of the independent variables

Variables	NDS diagnosis		Total
	No	Yes	
Route			
Count	77	13	90
Percentage within variable	85.6	14.4	100.0
Location			
Count	75	13	88
Percentage within variable	85.2	14.8	100.0
Weight			
Count	86	7	93
Percentage within variable	92.5	7.5	100.0
Total			
Count	238	33	271
Percentage within variable	87.8	12.2	100.0

NDS: Neurodevelopmental sequelae

2. Hospital procedures and diagnosis (HPD) accounted for 18.1% odds of having NDS. Means that HPD confers protection against NDS by largely 81.9%

Table 4: Spearman's rho correlation of neurodevelopmental sequelae with independent variables (*n*=271)

Variables	*R*	*P*
Age and NDS	0.023	0.578
Gender and NDS	0.014	0.676
Weight and NDS	−0.412	0.000*
Height and NDS	−0.046	0.554
NVD and NDS	−0.486	0.000*
CS and NDS	−0.792	0.000*
HMD and NDS	0.513	0.000*
HPD and NDS	−0.625	0.000*

*Significance. NDS: Neurodevelopmental sequelae, NVD: Normal virginal delivery, CS: Caesarean section, HMD: Home delivery, HPD; Hospital delivery

Table 5: Multicollinearity co-efficient[a]

Model 1	Unstandardized coefficients		Standardized coefficients β	*t*
	B	SE		
Constant	24.355	8.318		2.928
Weight	0.278	0.104	0.185	2.673
HMD	0.143	0.234	0.033	0.6111
NVD	0.161	0.124	0.153	1.298
HPD	0.127	0.075	0.333	1.693
CS	0.136	0.046	0.147	2.957

[a]Dependent variable: NDS. NDS: Neurodevelopmental sequelae, NVD: Normal virginal delivery, CS: Cesarean section, HMD: Home delivery, HPD: Hospital delivery

Table 6: Hierarchical logistic regression with 3 explanatory variables

Variables	*B* (SE)	OR (95% CI)	*P*	Nagalkerke R^2
CS	−3.34 (0.14)	0.035 (−0.239-0.309)	0.000	0.674
HPD	−1.71 (0.18)	0.181 (−0.172-0.534)	0.000	
NVD	−0.37 (0.13)	0.691 (−0.436-0.946)	0.000	
HMD	−0.28 (0.16)	0.756 (−0.305-1.070)	0.000	
Weight	−0.21 (0.01)	0.811 (0.791-0.831)	0.000	

χ^2=134.6, df=5, *P*<0.0001. NVD: Normal virginal delivery, CS: Cesarean section, HMD: Home delivery, HPD: Hospital delivery, SE: Standard error, CI: Confidence interval, OR: Odds ratio

3. Normal VD (NVD) accounted for 69.1% odds of having NDS. This means that NVD confers protection against NDS by only 30.9%
4. HMD accounted for 75.6% odds of having NDS. This means that HMD confers protection against NDS by only 24.4%
5. Weight accounted for 81.1% odds of having NDS. This means that a decrease in weight confers protection against NDS by only 18.9%.

Discussion

This current study evaluated the influence of route (vaginal vs. cesarean section), location of delivery (home vs. hospital), and birth weight on NDS among infants who suffered birth asphyxia. In this study, male infants have a higher risk of

developing NDS than female infants. This finding is congruent to that of Memon *et al*.[10] and Shrestha *et al*.[18] who reported that males have higher risks of developing NDS.

The finding of this study also indicated that 58.3% of infants were delivered at the hospital. This finding projects the delay in referral to advanced healthcare facilities in our community coupled with irregular antenatal follow-ups. The finding of this study agrees with hospital-based research by Shireen *et al*.[19] which reported that 60% of infants were delivered at the hospital, however, contrary to our study Shireen *et al*. reported regular antenatal check-ups by their community.

The finding of this study also showed that the route and location of deliveries have accounted much for the point prevalence of NDS than birth weight in infants who suffered birth asphyxia. In addition, the result also showed that VD has a positive relationship with NDS. This indicated that NDS increases as home delivery (HMD) or VD increases. Further, the results also indicated that HMD has higher chances of developing NDS than hospital delivery (HPD). The reason for this outcome could have been that infants delivered at home usually suffer birth asphyxia due to prolonged labor and lack of trained midwives. Moreover, this outcome could have also been due to the cultural influences or stigmatization of not being able to deliver at home that currently goes on in our community. This finding agrees with that of Natarajan *et al*.[20] which indicated the development of moderate-to-severe disabilities among infants delivered at a place other than the hospital.

The finding of this study also showed that infant's weight, cesarean section (SC), VD, and HPD were all negatively related to NDS. This outcome indicated that an increase in weight, CS, VD, or HPD may lead to a decrease in NDS. This outcome agrees with the study of Larsson *et al*.[21] on VD versus cesarean section which showed that the NVD and CS are negatively related to neonatal morbidity and disability. The outcome of this present study also indicated that HPD and CS had fewer chances of resulting in NDS. This outcome is not surprising as HPD may likely be prolonged or obstructive just like in the case of HMD, which may predispose to an emergency CS. Furthermore, Nigerian women's cultural beliefs made them prefer giving birth via VD without undergoing any CS because they strongly believed that, once a CS is always a CS. This finding agrees with the previous studies[22,23] which reported similar outcomes.

Even though the outcome of the present study indicated that CS confers protection against NDS by largely 96.5%, a study by Fantu *et al*.[24] on adverse birth outcomes have strongly contradicted this finding in which they reported that the infant's disability occurs more in CS than in VD. Their findings, however, may have largely been influenced by emergency CS due to prolonged or obstructive labor or other unaccounted factors. On the contrary, studies by Fantu *et al*.[24] and Halloran *et al*.[3] reported 50% of neonates suffering from encephalopathy as having brain affectation in both routes and locations of deliveries which partly supported our current findings. Routes and locations of deliveries have a significant influence on the development of NDS in infants who suffered birth asphyxia in Kano, North-West Nigeria. Also, CS and HPD confer much more protection against NDS than other predictor variables such as HMD, VD, and weight.

Conclusion

Routes and locations of delivery have a significant influence on the development of NDS in infants who suffered birth asphyxia in Kano, North-West Nigeria. In addition, CS and HPD confer much more protection against NDS than other predictor variables (HMD, VD, and weight).

Recommendation

Good quality of care during pregnancy should be ensured in Sub-Saharan Africa to reduce morbidity and mortality due to birth asphyxia.

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Conflicts of interest

There are no conflicts of interest.

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