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Impact of Place of Delivery on Neonatal Mortality in Rural Tanzania

Justice Ajaari, MSc (Med)^{1,2,3} , Honorati Masanja, PhD²; Renay Weiner, MSc (Med)^{3,4};
Shalom Akonvi Abokyi, MPH⁵; and Seth Owusu-Agyei, PhD¹

¹ Kintampo Health Research Centre, Kintampo, Ghana

² Ifakara Health Research and Development Centre, Ifakara, Tanzania

³ University of Witwatersrand, Johannesburg, South Africa

⁴ Soul City, Johannesburg, South Africa

⁵ John Snow Research and Training Institute, Accra, Ghana

 Corresponding author email: ajarijustice@gmail.com

ABSTRACT

Objectives

Studies on factors affecting neonatal mortality have rarely considered the impact of place of delivery on neonatal mortality. This study provides epidemiological information regarding the impact of place of delivery on neonatal deaths.

Methods

We analyzed data from the Rufiji Health and Demographic Surveillance System (RHDSS) in Tanzania. A total of 5,124 live births and 166 neonatal deaths were recorded from January 2005 to December 2006. The place of delivery was categorized as either in a health facility or outside, and the neonatal mortality rate (NMR) was calculated as the number of neonatal deaths per 1,000 live births. Univariate and multivariate logistic regression models were used to assess the association between neonatal mortality and place of delivery and other maternal risk factors while adjusting for potential confounders.

Results

Approximately 67% (111) of neonatal deaths occurred during the first week of life. There were more neonatal deaths among deliveries outside health facilities (NMR = 43.4 per 1,000 live births) than among deliveries within health facilities (NMR = 27.0 per 1,000 live births). The overall NMR was 32.4 per 1,000 live births. Mothers who delivered outside a health facility experienced 1.85 times higher odds of experiencing neonatal deaths (adjusted odds ratio = 1.85; 95% confidence interval = 1.33–2.58) than those who delivered in a health facility.

Conclusions and Public Health Implications

Place of delivery is a significant predictor of neonatal mortality. Pregnant women need to be encouraged to deliver at health facilities and this should be done by intensifying education on where to deliver. Infrastructure, such as emergency transport, to facilitate health facility deliveries also requires urgent attention.

Key Words

Neonatal mortality • Place of delivery • Tanzania • Socioeconomic status • Maternal age.

Introduction

Reducing neonatal mortality is a major thrust of current international public health policy^[1]. Place of delivery is an important aspect of reproductive health care. The place of delivery often determines the quality of care received by a mother and infant. It is an important factor in differential risks of neonatal mortality^[2]. Children delivered at a health facility are likely to experience lower mortality than children delivered at home because such facilities usually provide a sanitary environment and medically correct birth assistance^[3]. Although almost half of all deliveries in Tanzania take place at home^[4,5], studies on neonatal mortality have rarely considered the influence of place of delivery on neonatal mortality in Tanzania.

Greater attention to neonatal deaths could be met through providing epidemiological information regarding the places of neonatal deaths to policy makers and program planning authorities^[6]. This paper reports on the findings of a study conducted in the Rufiji Health and Demographic Surveillance Site (RHDSS) in rural Tanzania to assess the impact of place of delivery on neonatal mortality.

Methods

Study Area

This study was conducted using data from the RHDSS site in rural Tanzania; Rufiji is one of the six districts of Coast Region in Tanzania about 178 km south of Dar-Es-Salaam. The district has a population of about 226,000 people. The Rufiji demographic surveillance area comprises of 31 villages with a resident population of approximately 93,000 in 18,000 households. The RHDSS monitors households and members within households in cycles or intervals, known as 'rounds' of four months each. Members (residents) of the RHDSS are individuals who have resided in the survey area for a period of the previous four months and

plan to continue to live there. Rufiji district has 56 health facilities made up of two hospitals (one government and one mission); five government health centres and 48 government dispensaries. A private dispensary based at Kibiti offers mobile clinic services in some parts of the district. About 89% of the population lives within 5 km of a formal health facility.

Study Design

This was an analytical longitudinal study, based on secondary data from the RHDSS data on all neonatal deaths and live births that occurred from January 2005 to December 2006. The place of delivery was classified into two groups: health facility and outside health facility; thus deliveries that occurred at home or on the way to a health facility counted as outside health facility deliveries.

Study Sample

The analyzed sample comprised of all children younger than 28 days born between January 2005 and December 2006 to residents of the Rufiji DSA. A total of 5,124 live births and 166 deaths were registered during the defined study period.

Data

The variables used were selected from five datasets through an internal individual unique ID in the RHDSS database and extracted and combined into a new data set. The following were the key variables of interest:

- The main outcome variable was neonatal mortality, defined as any death occurring within 28 days of birth and coded using verbal autopsy instrument or death certificate mortality information.
- The main explanatory variable was place of delivery, which was defined as the place where a birth took place; either in a health facility or outside a health facility.

Other explanatory variables were maternal occupation, marital status, parity, infant's sex, maternal age at delivery, maternal education, and maternal household socio-economic status (SES)

Maternal Household Socio-Economic Status (SES)

Maternal household SES was constructed by using household characteristics and assets ownership data. The data was transferred from Microsoft visual fox pro professional edition version 5.0 database format into Stata version 10 software with stat transfer. This information was used in the construction of household wealth index using Principal Component Analysis (PCA) in Stata version 10 software. The following variables were used for the PCA analysis; Hoe, matchet, bicycle, vehicle, motorbike, radio, refrigerator, television, clock, sofa, bed, video, mattress, wardrobe, pump, livestock, sewing machine, chicken, bednet, satellite dish, ceiling fan, iron, floor type, wall type, roof type and power or energy source. The assets were combined into a wealth index using weights derived through principal components analysis (PCA).

PCA involves breaking down assets (e.g. radio, bicycle) or household service access (e.g. water, electricity) into categorical or interval variables. The variables are then processed in order to obtain weights and principal components. The Principal Component Analysis Model that was used to construct the wealth index (socio-economic indices) with household characteristics and ownership of assets was based on the model proposed by Filmer and Pritchett^[7] in 2001. This approach uses the PCA which involves a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables.

The model was based on the presence or absence of each asset or the nature of the housing materials .i.e. each asset was dummied with the response, 1 and 0. If the mother had the asset the

response was 1, otherwise it was assigned 0. The generated wealth index was used to categorize the households of mothers of the neonates into five socio-economic groups or quintiles; poorest, poorer, poor, less poor, and least poor to arrive at maternal household socio-economic status.

Statistical Analysis

Neonatal mortality rates (NMR) were calculated based on place of delivery (i.e., a health facility delivery or outside health facility delivery) and by dividing the total neonatal deaths that occurred in each place of delivery by the respective total number of live births that occurred in each place of delivery. The NMR was expressed as a rate per 1,000 live births. The NMR was also calculated for the total study population. Univariate and multivariate logistic regression models were used to assess the associations between neonatal mortality and place of delivery while adjusting for potential confounders such as maternal age at delivery, maternal occupation, maternal education, maternal household socio-economic status, parity and marital status. All analyses were done in Stata 10^[8].

Limitations of the Study

Information on pregnancy complications or events prior to delivery that may have influenced the risk of newborn deaths was not available. Again, data on prematurity which is a high risk factor for newborn deaths was not available.

The results of this study may not be generalizable to the entire rural Tanzania because quality of health care varies across the country.

Ethical Considerations

The study received ethical approval from the University of the Witwatersrand's Committee for Research on Human Subjects (Medical) (protocol number M071142) in South Africa and the Institutional Review Board of the Ifakara Health

Institute (ethical clearance number: IHI/IRB/No. A 021) in Tanzania. The datasets were anonymized.

Results

Socio-Demographic Characteristics.

A total of 5,124 live births and 166 neonatal deaths were recorded in the Rufiji Health and Demographic Surveillance Area (RHDSA) from January 2005 to December, 2006. There were slightly more boys 2,577 (50.3%) than girls 2,547 (49.7%) born during the study period. There were no significant sex differentials in neonatal deaths 84 (50.6%) females versus 82 (49.4%) males (Table 1). Approximately 67% (111) of neonatal deaths occurred during the first week of life (Table 1). Of the 5,124 births, 3,442 (67.2%) were born in health facilities and 1,682 (32.8%) were born elsewhere (Table 2).

Distribution of Neonatal Mortality Rates by Place of Delivery

Neonatal mortality was significantly higher (43.4 per 1,000 live births) in children born outside health facilities compared to those born in health facilities (27.0 per 1,000 live births) (Table 2).

Maternal Risk Factors Associated with Neonatal Mortality

Because the probability of neonatal death associated with most risk factors was smaller than 0.05, we have used odds and risks of neonatal death interchangeably. Table 3 presents the unadjusted analysis of the association between place of delivery, maternal risk factors and neonatal mortality. The univariate analysis found that mothers who delivered outside a health facility experienced 1.63 times higher odds of experiencing neonatal

deaths (unadjusted odds ratio [OR] = 1.63; 95% CI = 1.19–2.23) than mothers who delivered in a health facility (Table 3). Mothers who had no education experienced 0.78 times lower odds of experiencing neonatal deaths than mothers who had secondary education, though this association did not reach significance (unadjusted OR = 0.78; 95% CI = 0.35–1.73). Maternal age was significantly associated with neonatal mortality. Mothers in the age group 20–29 years experienced 0.48 times lower odds of experiencing neonatal deaths than mothers who were under 20 years old (unadjusted OR = 0.48; 95% CI = 0.33–0.71). Mothers aged 30 years and above experienced 0.63 times lower odds of experiencing neonatal deaths than mothers who were under 20 years old (unadjusted OR = 0.63; 95% CI = 0.43–0.92).

Parity was found to be protective against neonatal death since significance was reached. Compared with mothers with a parity of 1–2, mothers with a parity of 3–4 experienced 0.52 times lower odds of experiencing neonatal deaths and mothers who had a parity of 5 and more experienced 0.57 times lower odds of experiencing neonatal death. Maternal marital status, socio-economic status, and maternal occupation were not significantly associated with neonatal mortality.

In multivariate analysis, delivery outside a health facility remained a significant risk factor for neonatal mortality. Mothers who delivered outside a health facility experienced 1.85 times higher odds of experiencing neonatal deaths (adjusted OR = 1.85; 95% CI = 1.33–2.58) than those who delivered in a health facility (Table 4). Maternal age, maternal education, maternal marital status, parity, maternal socio-economic status, and maternal occupation were not statistically significantly associated with neonatal mortality.

Table 1. Distribution of Neonatal and Maternal Socio-demographic Characteristics in Rufiji Health and Demographic Surveillance System (HDSS), Tanzania 2005-2006

Variables	Frequency	Percentage (%)
Maternal Education		
No Education	2,222	43.4
Primary	2,742	53.5
Secondary or higher	160	3.1
Maternal Age		
<20 years	1,045	20.4
20-29 years	2,224	43.4
30+ years	1,855	36.2
Maternal Marital Status		
Not Married	1,127	22.1
Married	3,424	66.8
Widowed/ Divorced/Separated	437	8.5
Other	136	2.6
Maternal Occupation		
Unemployed	298	5.8
Farming and Animal Husbandry	3,707	72.4
Clerical & Management (White Collar jobs).	850	16.6
Student	134	2.6
Other	135	2.6
Parity		
1-2	1,058	20.6
3-4	2,324	45.4
5+	1,742	34
Maternal Household Socio-Economic Status (SES)		
Poorest	923	18
Poorer	1,092	21.3
Poor	1,134	22.1
Less poor	1,084	21.2
Least poor	891	17.4
Live Births		
Male	2,577	50.2
Female	2,547	49.8
Neonatal Age		
Under 8 days	46	1
8-28 days	4912	99
Neonatal Deaths		
Male	82	49.4
Female	84	50.6
Neonatal Age		
Under 8 days	111	66.9
8-28 days	55	33.1

Table 2. Distribution of Neonatal Mortality Rates by Place of Delivery per 1000 Live Births, Rufiji Health and Demographic Surveillance System (HDSS), Tanzania 2005-2006

	Neonatal Deaths n=166	Live births n=4,958	Total n=5,124	NMR* (95% CI)
Place of Delivery				
Health Facility	93	3,349	3,442	27.0 (21.52, 32.51)
OHF**	73	1,609	1,682	43.4 (33.44, 53.35)
Total	166	4,958	5,124	32.4 (27.46, 37.32)
Parity				
2-Jan	53	1,005	1,058	52.7 (36.6, 63.6)
3-4	62	2,262	2,324	26.7 (20.0, 33.3)
5+	51	1,691	1,742	29.3 (21.2, 37.3)
Education				
Secondary or higher	7	153	160	43.7 (11.3, 76.2)
Primary	82	2,660	2,742	29.9 (23.4, 36.4)
No education	77	2,145	2,222	34.6 (26.9, 42.4)
Maternal Age				
Under 20 years	52	993	1,045	49.7 (36.2, 63.3)
20-29 years	55	2,169	2,224	24.7 (18.2, 31.3)
30+ years	59	1,796	1,855	31.8 (23.7, 39.9)
Maternal Occupation				
Clerical & Management (White Collar jobs)	28	822	850	32.9 (20.7, 45.1)
Unemployed	112	3,595	3,707	30.2 (24.6, 35.8)
Farming and Animal Husbandry	11	287	298	36.9 (15.1, 58.7)
Student	7	127	134	52.2 (13.5, 90.9)
Other	8	127	135	62.9 (18.2, 100.3)
Maternal Marital Status				
Married	110	3,314	3,424	32.1 (26.1, 38.1)
Not Married	41	1,086	1,127	36.4 (25.2, 47.5)
Widowed/ Divorced/Separated	13	424	437	29.7 (13.6, 45.9)
Other	2	134	136	14.7 (-5.6, 35.1)
Maternal SES				
Least poor	22	869	891	24.7 (14.4, 35.0)
Poorest	32	891	923	34.6 (22.6, 46.7)
Poorer	41	1,051	1,092	37.5 (26.0, 49.0)
Poor	33	1,101	1,134	29.1 (19.0, 39.0)
Less poor	38	1,046	1,084	35.0 (23.9, 46.2)

NMR*= Neonatal Mortality Rate per 1,000 live births

OHF**= Out-Side Health Facility Deliveries/Births

Table 3. Unadjusted Odds Ratio (OR) Estimates and 95% Confidence Intervals (CI) for Maternal Risk Factors Associated with Neonatal Mortality (Univariate Logistic Regression Analysis)**Univariate Analysis (unadjusted)**

Variable	Unadjusted Odds Ratio	95% Confidence Interval	p-value
Place of Delivery Health Facility*			
Outside Health Facility	1.63	1.19, 2.23	0.002
Parity			
1-2*	1	-	-
3-4	0.52	0.35, 0.75	0.001
5+	0.57	0.38, 0.84	0.005
Education			
Secondary or higher*	1	-	-
Primary	0.67	0.30, 1.48	0.327
No education	0.78	0.35, 1.73	0.548
Maternal Age			
under 20 years*	1	-	-
20-29 years	0.48	0.33, 0.71	<0.001
30+ years	0.63	0.43, 0.92	0.016
Maternal Occupation			
Clerical & Management (White Collar jobs)*	1	-	-
Unemployed	0.91	0.60, 1.39	0.678
Farming and Animal Husbandry	1.12	0.55, 2.29	0.553
Student	1.62	0.69, 3.78	0.692
Other	1.85	0.82, 4.15	0.824
Maternal Marital Status			
Married*	1	-	-
Not Married	1.13	0.79, 1.63	0.489
Widowed/ Divorced/Separated	0.92	0.51, 1.65	0.79
Other	0.45	0.11, 1.84	0.266
Maternal Socio-Economic Status			
Least poor*	1	-	-
Poorest	1.42	0.82, 2.46	0.213
Poorer	0.54	0.91, 2.60	0.107
Poor	1.18	0.68, 2.04	0.545
Less poor	1.43	0.84, 2.44	0.184

* Reference Group

Table 4. Adjusted Odds ratio (OR) Estimates and 95% Confidence Intervals for Maternal Risk Factors Associated with Neonatal Mortality (Multivariate Logistic Regression Analysis)

Variable	Adjusted Odds Ratio	95% Confidence Interval	p-value
Place of Delivery			
Health Facility*	1	-	-
Outside Health Facility	1.85	1.33, 2.58	<0.001
Parity			
1-2*	1	-	-
3-4	0.61	0.37, 1.01	0.056
5+	0.53	0.27, 1.02	0.06
Education			
Secondary or higher*	1	-	-
Primary	0.61	0.27, 1.37	0.233
No education	0.69	0.30, 1.57	0.379
Maternal Age			
under 20 years*	1	-	-
20-29 years	0.65	0.39, 1.08	0.1
30+ years	0.97	0.51, 1.83	0.931
Maternal Occupation			
Clerical & Management (White Collar jobs)*	1	-	-
Unemployed	0.97	0.61, 1.53	0.896
Farming and Animal Husbandry	0.92	0.44, 1.90	0.828
Student	1.02	0.42, 2.48	0.957
Other	1.34	0.58, 3.06	0.487
Maternal Socio-Economic Status			
Least poor*	1	-	-
Poorest	1.42	0.80, 2.50	0.228
Poorer	0.67	0.96, 2.88	0.067
Poor	0.22	0.69, 2.13	0.489
Less poor	0.37	0.79, 2.37	0.262

* Reference Group

Discussion

The results of this study clearly indicate that delivery outside a health facility is more likely to lead to neonatal death compared with delivery in a health facility; this confirms the role of place of delivery on newborn survival. Place of delivery has consistently been found to be associated with maternal and neonatal outcomes^[9,10,11]. Childbirth in a health institution attended to by a trained medical staff reduces maternal and neonatal mortality and morbidity compared to home births^[12,13,14]. Most of the studies reported are, however, based on health facility data only which do not demonstrate the actual magnitude of the problem. The community data analyzed here clearly demonstrates this point.

Higher neonatal mortality was found among children born outside health facilities (43.4 versus 27.0 per 1,000 live births), even though health facility deliveries generally have a far greater likelihood of complications likely to result in neonatal death. This is as a result of the health-seeking behaviour where most deliveries will be attended to at home until it becomes complicated; and it is only at this stage that the home delivery attendants will refer to the health facilities. Weak health systems are also likely to account for neonatal deaths among the health facility deliveries.

The overall neonatal mortality in Rufiji district, which was 32.4 per 1,000 live births, is similar to the neonatal mortality rate of 32.0 per 1,000 live births reported by the 2004-05 Tanzania Demography and Health Survey (TDHS). The findings also confirm the average NMR of 33 per 1,000 live births for middle-income and low-income countries where 99% of neonatal deaths occur. The overall NMR is consistent with NMRs reported in other Sub-Saharan African countries such as Uganda (32/1,000), Burkina Faso (31/1,000) and Madagascar (32/1,000)^[15]. The NMR of 43.4 per 1,000 for births that occurred outside health facilities is close to England's NMR of 41 per 1,000 live births in 1905, and the average for Sub-Saharan Africa today^[16]. The

overall NMR of 32 per 1,000 live births for Rufiji indicates a great improvement in neonatal deaths in a rural Tanzania district, though there is much room for further improvement.

Conclusions and Public Health Implications

The findings from this study lend credence to the vital role that the place of delivery plays in neonatal survival as delivery outside a health facility is a risk factor of neonatal mortality. This finding concurs with the 2005 World Health Report which states that, giving birth in a health facility (not necessary a hospital) with professional staff is safer by far compared to doing so at home^[17]. It also conforms to the results of Demographic and Health Survey (DHS) data from 40 countries collected between 1995 and 2003 which reported that more than 50% of neonatal deaths occur after home birth without skilled care attendance^[18]. Furthermore, these results are consistent with a study in rural Tanzania which reported that home births without a trained attendant resulted in a three times higher perinatal mortality compared with those in a health facility with trained attendants in rural Tanzania^[19]. These findings are in line with those of a study in Papua New Guinea which reported high rate of obstetric complications among apparently normal pregnancies deliveries at home in Papua New Guinea^[20]. These findings have important implications for all stakeholders and policy makers in the fight against neonatal mortality in sub-Saharan Africa in general and Tanzania in particular.

The use of longitudinal population-based data is an ideal way of communicating the impact of home deliveries on neonatal mortality. The United Republic of Tanzania's health system must be strengthened to promote universal facility delivery in order to achieve the Millennium Development Goal 4 and to comply with the National Strategy for Growth and Reduction of Poverty (NSGRP) which aims to

reduce infant mortality from 95 infant deaths per 1,000 live births in 2002 to 50 per 1,000 by 2010.

In conclusion, the place of delivery has a significant impact on neonatal survival. The authors therefore

recommend the development and implementation of programs that would educate, encourage and support pregnant women to give birth in health facilities.

Conflict of interest: None

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