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ARTICLE

Predisposing factors of neonatal morbidity in Gicumbi District, Rwanda

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Background: Rwanda has registered tremendous achievements in the health sector. However, neonatal morbidity remains high in some areas. This study aims to determine the prevalence and predisposing factors of neonatal morbidity in the Gicumbi District. **Methods:** The study was a retrospective, cross-sectional study. Overall population of interest comprised 349 neonates. Quantitative data were collected using a pre-tested data extraction tool which comprised of general characteristics of mothers and neonates, social factors, medical insurance and physiological factors. **Results:** The study found that the prevalence of neonatal morbidity is 28.4%. Bivariate analysis shows that 8 variables were statistically significant with neonatal morbidity. In multivariable analysis, factors identified as statistically associated with neonatal morbidity were mothers who did not have any antenatal care during pregnancy (AOR = 5.3; 95% CI = −1.313–22.118, $P < 0.019$). **Conclusion:** Prevalence of neonatal morbidity was significant among neonates born in Gicumbi District and mothers who did not have any antenatal care during pregnancy are most vulnerable thus, public health staff, leaders at the facility, and national level are advised to assess all barriers and enablers of Antenatal care coverage.

Key words: Factors, Neonate, Morbidity, Gicumbi, Public health

***Abbreviations*:**

CBHI, community based health insurance; RSSB, Rwanda Social Security Board; AOR, adjusted odds ratio.

***Competing interests*:**

The authors declare that they have no conflict of interest.

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Background

The neonatal period is defined as up to the first 28 days of life of the newborn. During this period, the newborn is vulnerable and has high risks for morbidities and mortalities. Globally, each year estimates show that 130 million infants are born and 2. 5 million die during the neonatal period [1]. Factors like poor maternal health, management of pregnancy and delivery complications and poor medical & nursing care during childbirth or shortly after the birth of neonate predispose to neonatal deaths and morbidities [2]. These factors predisposing neonatal deaths and morbidities are poorly measured in the developing world but some studies have revealed that neonatal asphyxia, severe neonatal sepsis, prematurity and low birth weight complications and tetanus are believed to be major components [3]. Rwanda's neonatal mortality remains high and is estimated to be 20 per 1,000 live births according to the 2014–15 Rwanda demographic and health survey [4]. The interventions that aim at reducing the number of deaths of neonates vary in different ways and by actors involved in implementation. These interventions are categorized into 2 classes based on demand or supply [2]. From the demand aspect, interventions are based necessarily on the mother: the first concern is on spotting the gestational age or the pregnancy stage occurring in 3 phases: prenatal, intrapartum and postpartum [5].

According to the supply, interventions do not necessarily depend on mother. They are directed on the community, health services access, services cost and interventions on drugs [2]. Community interventions engage community members to play as main actors in community health: people like mothers, community leaders, medical doctors, nurses, traditional birth attendants can play key roles to promote basic neonatal care, breastfeeding and community mobilization in health promotion [5, 7, 8].

Second interventions involve the improvement of health services access concerning changes of structures in processes or institutions. Interventions like the health system structure changes, application of technologies related to pregnancy which are new, improvement of drug supply chains and introduction of new specialized centers or medical devices [1].

Thirdly, some countries work on trying to reduce or eliminating maternal health services fees by waiving the payments for service users. This increases access to maternal health and hence, having good neonatal outcomes. The final intervention on the supply aspect plays on pharmacological interventions [2].

Lastly, focused and comprehensive high impact interventions of significant reduction of neonatal deaths depend on clear knowledge on their predisposing factors. Therefore, this study aims at identifying the prevalence and predisposing factors of neonatal mortality in Gicumbi District, which is located in rural area, Northern Province so as to inform public health.

Rwanda is recognized to achieve different goals of Millenium Development Goals including goal number 4: reduction of child mortality. In 2015, neonatal mortality rate was at 20/1,000 which makes 45.9% of reduction over 1 decade. This reduction is lower than the one observed in infant mortality (73.6%) and under-5 mortality (67.1%). According to Rwanda Demographic Health Survey 14–15, the highest neonatal mortality rate was observed in the following groups: rural in residence group, South and Western provinces for province group, no education, male, mother age at birth < 20, first born in birth order, small and very small newborn in the birth size group and lastly in lowest wealth group [3].

According to recent Rwanda demographic health survey done in 2014–2015, Gicumbi District had 22 newborn deaths per 1,000 live births, 2 deaths/1,000 higher than the national rate and according to unpublished health management information system data of 2018, Gicumbi District registered highest neonatal admission case fatality rate at 17% and its hospital, Byumba Hospital contributed to 93% (117/126) of all neonatal deaths in Gicumbi District. The aim of this study is to determine prevalence and predisposing factors of neonatal morbidity in Gicumbi District.

Methods

Participants

This is a cross-sectional study. Data collection was done from patient records of hospital and health centers in Gicumbi District, Rwanda. All medical records of mothers who delivered and their neonates between 1st April to 30th June 2019 in Byumba Hospital and 5 health centers located in Gicumbi District. This district registered higher neonatal mortality rate at (22/1,000) in 2015 than the country's overall rate at 20/1,000. It has 1 public hospital and 24 health centers. The hospital and 5 health centers with the highest number of deliveries in 2018 were sampled: Rutare, Miyove, Kigogo, Byumba and Mulindi Health Centers.

Sample size

The sample size was calculated using the following formula:

$$n = \frac{N}{1 + N\,(e)^2}$$

Whereby n = our sample size within the population targeted, N = the target population which will give us a sample size to use in the study, e = the sampling error which is 0.05%.

Therefore, the sample size was

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$$n = \frac{2720}{1 + 2720\ (0.05)^2}$$

$$= 348.7 \text{ approximately } 349$$

The sample size used was 349 study participants in quantitative evaluation dispatched as follow: Byumba Hospital 188 samples (total births: 863), Rutare Health Center: 36 samples (total births: 164), Miyove Health Center: 34 samples (total births: 155), Kigogo Health Center: 31 samples (total births: 140), Byumba Health Center: 30 samples (total births: 140), Mulindi Health Center: 30 samples (total births: 136).

Inclusion criteria

All mothers who delivered and their newborns registered on maternity and neonatal registry book from April to October 2019 in maternity and neonatology unit of the Byumba Hospital and Rutare, Miyove, Kigogo, Byumba and Mulindi Health Centers were included.

Exclusion criteria

Maternity and neonatal medical record with incomplete information, age greater than 28 days for infants and mothers with stillbirths.

Sampling techniques

Maternal and neonatal medical record done from April to October 2019 in maternity and neonatology was retrieved by using data extraction checklist which was approved by Mount Kenya Institutional Review Board and Byumba Hospital Ethics Committee.

Predisposing factors–

General characteristics of mothers and neonates: neonatal sex, birth place, gestational age, birth weight, twin baby, maternal age, place of birth of neonate. Social influences: number of antenatal care, gravida, social category, education level, marital status and medical insurance. Maternal and neonatal related factors: maternal comorbidities, induction of labor by misoprostol, augmentation of labor by oxytocin, phase of labor, cord prolapse, placenta previa, placenta abruption, previous scarred uterus, maternal HIV, APGAR score at 0 minute, 5 minutes, 10 minutes, mode of delivery, birth weight, congenital anomaly. The neonatal outcome was: neonatal admission.

Data collection procedure and quality assurance

Data were extracted by 2 trained nurses who had diploma and experience in the setting. The overall data collection process was supervised by researchers. A data extraction tool (Appendix 1) was elaborated for collecting socio-demographic, and clinical data. Researchers used registers and patient's files to extract information. The study was qualified for good quality when it met the criteria of validity and reliability. In this study reliability of the data collection was ensured by piloting the tool. We ensured the internal validity of our data extraction tool by pre-testing to confirm whether it would be able to collect data meeting our study objectives. One gynecologist and pediatrician checked the data extraction tool if it could measure study variables to respond to research questions. Inputs from my supervisors were given and corrections were made accordingly. This was the process with aim of finding information, supporting decision-making and possibly drawing research conclusions. It included steps like data cleaning, transforming, inspecting and modeling [14] The analyses were done in consultation with my supervisors. Data entry was done based on the extraction tool. The analysis was done using the SPSS version 21.

Variables

The primary outcome was a binary variable of neonatal morbidity, defined as any admission for any cause of a newborn from 0 to 28 days of life. Independent variables were general characteristics of neonates: sex, birth place (province and district), weight, age. General characteristics of mothers were: age, number of antenatal care done, gravida, Ubudehe category, education, marital status and medical insurance. Ubudehe is a home-grown development program whereby citizens are placed into different categories by socioeconomic status as defined in accordance with Ministry of Local Government criteria: communities periodically rank households on a scale of 1 to 4 according to their perceived poverty and vulnerability status, with a score of 1 being the most vulnerable and 4 the least vulnerable. Ubudehe categories are linked to health insurance payment modalities: Category I pays 2,000 Rwandan francs (2.1 US $) per person per year and this category is supported by the government and other donors, category II pays 2,000 Rwandan francs (2.1 US $) per person per year, category III pays 3,000 Rwandan francs (3.1 US $) per person per year, category IV pays 7,000 Rwandan francs (7.4 US $) per person per year.

Maternal factors: maternal comorbidities, rupture of membranes, induction of labor by misoprostol, augmentation of labor by oxytocin, admission of mother in phases of labor, presence of cord prolapse, placenta abruption, placenta Previa, previous scarred uterus, and maternal HIV; neonatal factors were place birth, APGAR score at 0 minute, 5 minute and 10 minute, mode of delivery, birth weight and presence of congenital anomaly, admission in neonatology.

Statistical methods and data analysis

Admission of neonate in hospital for any condition (morbidities) was the event of interest. After data cleaning using Excel, they were imported and analyzed using SPSS version 21.0. In the bivariate analysis,

logistic regression was used to assess the association between categorical variables and outcome. Variables that were statistically significant at the 5% level of significance were retained in the final model building. In the multivariate analysis, potential factors of neonatal morbidity were assessed using logistic regression. Variables that were not significant were eliminated using backward stepwise method.

This included data collection instrument, procedure of data collection instruments and validity as well as reliability of data extraction tools. The development of data extraction tool was based on patients' data available in files and what literature was telling us on predisposing factors of morbidity of neonates as well as the point of views of health care providers (medical doctors, community health workers, midwives and nurses) on factors that kept contributing on neonatal morbidity. The tool was reviewed by supervisors as well as Mount Kenya University internal examiners. The tool's content and structure were consulted. The quantitative data extraction tool had three sections. The first section captured the sociodemographic information of the neonate, the second with maternal factors, and the third section captured the factors related to neonates themselves. The dependent variables were neonatal admission (morbidity).

Ethics

This study ensured that patient privacy is respected by keeping all the information obtained from the files of patients confidential and avoiding to be disclosed to anyone except the research supervisors. Patients had always the right of deciding the right to decide the time, overall situations and degree at which his/her information can be shared. Quantitative data extracted from the records were de-identified before being transferred for analysis. Only the researcher was able to link any personally identifiable information to the de-identified dataset. A locked cupboard of the researcher kept all written documentation. The computer with a protected password stored all digital data. No information identifying any person would be presented in any written reports resulting from this research. Ethical approval was obtained from Byumba Ethical Committee and Mount Kenya Institutional Review Board (Ethical approval Number: MKU04/DVCARA/2018-2019/042).

Results

Neonatal and maternal characteristics

As indicated in the table below, the general characteristics show that female neonates occupy 53.9% (n = 188), the majority of neonates were born with normal birth weight (82.5%, n = 288). Above half of them were born at hospital (53.9%, n = 188). Near all births occurred in Northern province (n = 346, 99.1%). The majority of neonates are from Gicumbi District (93.7%) (Table 1).

Rwanda's population is categorized in social categories called "Ubudehe" which is a development program. More than half of the study population are in social category 3 (54.2%) followed by category 2 (29.2%) and category 1 (11.4%). Ninety percent of mothers belong to Mutuelle (community health based insurance). Mothers who are married, single and divorced constitute the subgroups of marital status and 94.3% in this research are married. Most of mothers attended primary school (n = 197, 56.4%) and close to half (n = 167, 47.9%) are aged between 25 and 34 years' old. Close to 3 quarters of mothers had 3 to 4 pregnancies (n = 247, 70.8%) (Table 1).

Prevalence of neonatal morbidity

Any neonate who was admitted for any condition during the neonatal period were considered in determination of neonatal morbidity. Twenty-eight-point-four percent of all neonates were admitted for any disease either in hospital or health centers (morbidity) during the neonatal period in the study period making the prevalence of neonatal morbidity in Gicumbi District at 28.4% (Figure 1).

Predisposing factors of neonatal morbidity in Gicumbi District

The Table 2 resumes association of sociodemographic, maternal and neonatal factors with neonatal morbidity: mothers' social category ($P < 0.001$), education ($P = 0.026$), health insurance ($P = 0.013$), marital status ($P = 0.003$), number of antenatal care (0.037), maternal comorbidities, ($P < 0.001$), induction of labor with misoprostol ($P < 0.001$), prolonged rupture of membranes ($P < 0.001$) were statistically significant with neonatal morbidity.

Neonates who had morbidities (admitted for any

Table 1 General characteristics of mothers and neonates

Variables	N = 349	%
Neonatal gender		
Male	161	46.1
Female	188	53.9
Birth weight in grams for newborn		
Extremely low (500–1,000)	9	2.6
Very low (1,001–1,500)	11	3.2
Low (1,501–2,499)	33	9.5
Normal (2,500–4,000)	288	82.5
Macrosomic (> 4000)	8	2.3
Place of birth of newborn		
Home	1	0.3
Health center	160	45.8
Hospital	188	53.9

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Table 1 General characteristics of mothers and neonates (*continued*)

Variables	N = 349	%
Birth province for newborn		
North	346	99.1
East	3	0.9
Birth district for newborn		
Gicumbi	327	93.7
Gatsibo	4	1.1
Burera	9	2.6
Rulindo	9	2.6
Maternal social category (Ubudehe)		
Category one	51	14.6
Category two	102	29.2
Category three	188	53.9
Category four	4	0.3
Maternal education		
Illiterate	9	2.6
Primary	197	56.4
Secondary	115	33.0
College/university	28	8.0
Maternal marital status		
Single	17	4.9
Married	315	90.3
Divorced	17	4.9
Maternal health insurance		
None	10	2.9
CBHI	307	88.0
RSSB	19	5.4
Private	13	3.7
Maternal age group (years)		
15–24	111	31.8
25–34	167	47.9
35–44	67	19.2
> 44	4	1.1
Number of antenatal care done by mothers		
0	7	2.0
1 to 3	74	21.3
4	266	76.7
Phase of labor in which mother was admitted		
Latent	69	19.8
Active	266	76.2
Expulsive	14	4.0
Maternal gravida_group		
Nulliparous	52	14.9
Multiparous	297	85.1
Source: primary data		

CBHI, community-based health insurance; RSSB, Rwanda Social Security Board.

disease during the neonatal period) were n = 99. The majority of them were found for mothers with no induction of labor (n = 89), no prolonged rupture of membranes (n = 63), no maternal comorbidities (n = 54), completed all 4 antenatal care visits (n = 72), have community based health insurance (n = 84), and attended primary education (n = 68).

Multivariate analysis

Multiple logistic regression analysis was applied to identify the variables independently associated with neonatal morbidity. Mothers' social category, education, health insurance, marital status, number of antenatal care, maternal comorbidities, prolonged rupture of membranes and induction of labor by misoprostol were significant at bivariate analysis. Upon fitting these factors using binary logistic regression and by specifying 'backward conditional' method with removal at $P < 0.05$, seven variables were significantly associated with neonatal morbidity.

Mothers who were in social category two or three were 0.23 times less likely to have neonatal morbidity compared to those in category one (AOR = 0.235; 95% CI = 0.121–0.453; $P < 0.001$). Married and divorced mothers were 0.192 times less likely to have neonatal morbidity than those who are single (AOR = 0.192; 95% CI = 0.065–0.573; $P = 0.003$). Mothers who are using "Mutuelle" as health insurance were 0.08 less likely to have neonatal morbidity compared to those with Rwanda Social Security Board (public servant insurance scheme) (AOR = 0.013; 95% CI = 0.013–0.051, $P = 0.007$) (Table 3).

Mothers who did not have any antenatal care during pregnancy were 5.3 times more likely to have a neonate diseased during neonatal period (neonatal morbidity) compared to those who completed 4 standard antenatal cares (AOR = 5.3; 95% CI = −1.313–22.118, $P < 0.019$). Mothers who did not have co-morbidities are 0.182 times less likely to have a diseased newborn (morbidity) (AOR = 0.182; 95% CI = −0.096–0.345, $P < 0.001$) (Table 3).

The study found that intrapartum factors like mothers with prolonged rupture of membranes are 0.071 less likely to have neonatal morbidity than those with no history of prolonged rupture of membranes (AOR = 0.071; 95% CI = 0.033–0.0152, $P < 0.001$). Mothers with the induction of labor by misoprostol are 0.109 times less likely to have neonatal morbidity than those who did not (AOR = 0.109; 95% CI = 0.029–0.04, $P = 0.001$) (Table 3).

Discussion

Neonatal morbidity was found to be statistically associated with mothers who did not have any antenatal care during pregnancy. Blondel et al. (1993) found the same findings by linking poor attenders of antenatal

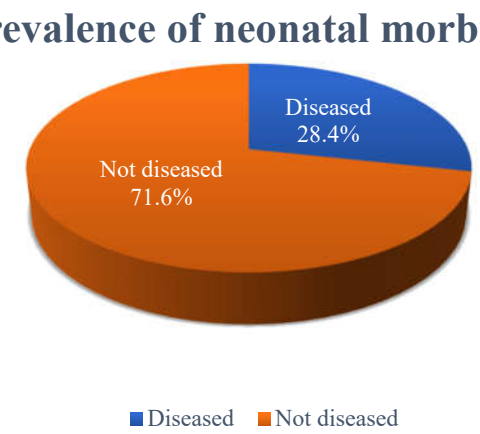

Figure 1 Prevalence of neonatal morbidity

Table 2 Association between sociodemographic, maternal & neonatal factors with neonatal morbidity

Variables	Diseased		Not Diseased		Chi square	*P* value
	n	%	n	%		
Social category (Ubudehe)					72.960	< 0.001
Category 1	29	55.2	22	44.8		
Category 2	49	48.0	53	52.0		
Category 3	18	9.5	170	90.5		
Category 4	0	0.0	1	100.0		
Education					9.269	0.026
Illiterate	3	33.3	6	66.7		
Primary	68	34.5	129	65.5		
Secondary	22	19.1	93	80.9		
College/University	6	21.4	22	78.6		
Marital status					11.692	0.003
Single	11	64.7	6	35.3		
Married	84	26.7	231	73.3		
Divorced	4	23.5	13	76.5		
Health insurance					10.814	0.013
None	7	70.0	3	30.0		
CBHI	84	27.4	223	72.6		
RSSB	3	15.8	16	84.2		
Private	5	38.5	8	61.5		
Number of antenatal care visit					4.348	0.037
No antenatal care visit	6	66.7	3	33.3		
1 to 3 antenatal care visits	21	28.4	53	71.6		
Completed all 4 antenatal care visits	72	27.1	194	72.9		
Maternal comorbidities					25.955	< 0.001
Yes	45	48.9	47	51.1		
No	54	21.0	203	79.0		
Prolonged rupture of membranes					65.600	< 0.001
No	63	20.8	240	79.2		
Yes	36	78.3	10	21.7		
Induction of labor by misoprostol					16.000	< 0.001
No	89	26.5	247	73.5		
Yes	10	76.9	3	23.1		
Phase of labor in which mother was admitted					3.700	0.157
Latente	17	24.6	52	75.4		
Active	75	28.2	191	71.8		
Expulsive	7	50.0	7	50.0		

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Table 2 Association between sociodemographic, maternal & neonatal factors with neonatal morbidity (*continued*)

Variables	Diseased		Not Diseased		Chi square	*P* value
	n	%	n	%		
Placenta previa					2.1	0.140
No	97	28.0	249	72.0		
Yes	2	66.7	1	33.3		

*, significant at $P < 0.05$ bolded.
CBHI, community based health insurance; RSSB, Rwanda Social Security Board.

Table 3 Multivariable analysis for factors associated with neonatal morbidity

Variables	AOR	95% CI		*P* value
		Lower	Upper	
Social category (Ubudehe)				
Category one	Reference			
Category two, three and four	0.235	0.121	0.453	< 0.001
Marital status				
Single	Reference			
Married/divorced	0.192	0.065	0.573	0.003
Maternal health insurance				
Mutuelle	0.080	0.013	0.051	0.007
No insurance	0.496	0.141	1.744	0.274
Private insurance	0.300	0.057	1.584	0.156
RSSB	Reference			
Maternal education				
None	0.409	0.055	3.035	0.382
Primary	0.517	0.200	1.337	0.174
Secondary	1.153	0.418	3.182	0.784
University	Reference			
Maternal antenatal care				
No antenatal care visit	5.300	1.313	22.118	0.019
1 to 3 antenatal care visits	1.068	0.602	1.894	0.823
Completed 4 antenatal care visits	Reference			
Prolonged rupture of membranes				
Yes	0.071	0.033	0.152	< 0.001
No	Reference			
Induction of labor				
Yes	0.109	0.029	0.040	0.001
No	Reference			
Maternal comorbidities				
Yes	Reference			
No	0.182	0.096	0.345	< 0.001

* Significant at $P < 0.05$ bolded; AOR, adjusted odds ratio; CI, confidence interval.

care visits associated with neonatal morbidities like preterm delivery (odds ratio 5.2: 4.3–6.3) and low birth weight (odds ratio 4.6: 3.7–5.6) [12].

The present study found that mothers who had no comorbidities were negatively associated with neonatal morbidity. The same findings as Auger et al. (2011) who established that preterm birth rates were higher among mothers with comorbidity (10.9%) compared to those without comorbidity (4.7%) [9].

The use of "Mutuelle" as health insurance was negatively associated with neonatal morbidity and this is in contrast with a study done by Doukkali et al. (2016) who investigated factors of neonatal morbidity at one of the provincial hospital in Morocco. Their findings were consistent with 89.1% of mothers with no medical coverage associated with neonatal morbidity [10].

This study finds that prolonged rupture of membranes and induction of labor by misoprostol had lower odds with neonatal morbidity. This is in contrast with Al-Lawama, et al. (2019) findings where they linked prolonged rupture of membranes and neonatal sepsis, but it is in line with Souter V. (2019) who found that term elective induction was not associated with any statistically significant increase in adverse newborn

infant outcomes [11, 12]. This study was limited to health facilities of one district and therefore it cannot be generalized to other settings.

Conclusion

Prevalence of neonatal morbidity was significant among neonates born in Gicumbi District and mothers who did not have any antenatal care during pregnancy are most vulnerable thus, public health staff, leaders at the facility, and national level are advised to assess all barriers and enablers of antenatal care coverage.

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