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"Comparative risk factors for neonatal mortality in Rwanda: case study of Eastern and Western Provinces"

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A dissertation submitted to the College of Medicine and Health Sciences, the School of Public Health in partial fulfilment of the requirements for the degree of Master of Public Health.

Supervisor: **Ass.Prof. Manassée NZAYIRAMBAHO**

Kigali, October 2019

DECLARATION

I, Madeleine MUKESHIMANA, do hereby declare and certify that this dissertation entitled **Comparative risk factors for neonatal mortality in Rwanda: case study of Eastern and Western Provinces**" contains my own and original work and, it has never been presented or submitted in whole or in part to any other institution or university. This study contains my own work and where assistance was sought it was acknowledged specifically.

It is submitted to the College of Medicine and Health Sciences in partial fulfillment of the academic requirements for the award of Master of Public Health at University of Rwanda

MADELEINE MUKESHIMANA, 10104765

Signed :……..

Date :…….

Manassée NZAYIRAMBAHO

Signed:……..

Date:…….

DEDICATION

To God the Almighty,

To my Beloved Husband,

To our children,

To my Supervisor,

To my classmates,

To my Friends and Relatives,

This piece of work is dedicated.

ACKNOWLEDGEMENTS

I would like to thank the University of Rwanda, College of medicine and health sciences/ School of public health for affording me the unimaginable opportunity to complete my study here, despite all challenges which had frustrated all my efforts. I would like to extend my sincere gratitude and genuine appreciation to God, the Almighty for abundant blessings, guidance and protection to keep me alive and unconditional love during my work and studies.

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ABSTRACT

Globally, neonatal mortality represents around 40 percent of all mortality among children under five, with the neonatal deaths concentrated in first week of life. The associated factors include but not limited to socio-economic and healthcare-related factors. This study aimed to identify and compare factors that may be associated with neonatal mortality in Western and Eastern provinces of Rwanda. A cross-sectional study using quantitative and analytical methods was applied. The data were extracted from RDHS 2014/2015, for the women aged 15-49 years, who had given birth to live infants within the two years preceding the survey. For overall (n=6 016) live births, the 50.8 percent were from Western province and 49.2 percent in Eastern province. The early neonatal mortality was at 91.2%. Factors most likely associated with neonatal mortality were living in rural area in both provinces, born with normal and high birth weight in Western province, being of 5^{th} or above birth order, number of tetanus toxoid injection in Eastern province. On other hand, mother's age group of 41 years or above, head of household age group of 36 years or above had a protective effect against early neonatal mortality. Poor neonatal outcome is still a challenge in this population. Residing in rural area in the two provinces, being the 5^{th} + birth order in the Eastern province remain the key determinants more likely associated with the neonatal mortality. Thus, focusing on improving maternal and child health in rural areas is of key importance to continuously decrease the neonatal mortality in the two provinces.

Key words: factors, neonatal mortality, province, associated.

LIST OF SYMBOLS AND ACRONYMS.

ANC	Antenatal care
CBHI	Community-based health insurance
CHW	Community health worker
iCCM	Integrated Community Case Management
LMICs	Low and middle incomes countries
LBW	Low birth weight
HBW	High birth weight
MDGs	Millennium Developmental Goals
WHO	World Health Organization
MLCC	Midwife-led continuity of care
PNC	Post Natal Care
RDHS 2014/15	Rwanda Demographic Health Survey 2014-2015
SSA	Sub Saharan Africa
TTI	Tetanus toxoid injection
UNICEF	United Nations International Children's Emergency Fund

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KEY CONCEPTS

- **The neonatal period**: first 28 days of life. It is the most vulnerable time for a child's survival (WHO, 2016).
- **Neonatal mortality:** the probability of dying within the first month of life(1).
- **Neonatal deaths** :deaths during the first 28 completed days of life(1)
- **Early neonatal death**: is the death of a neonate within 7 days of birth, and accounts for three-quarters of all neonatal deaths (WHO, 2016)
- **Later neonatal death:** is the death of a neonate after 7 days of birth but not after 28 days of life since birth (WHO, 2016).
- **Post-neonatal mortality:** the probability of dying between the first month of life and the first Birthday (computed as the difference between infant and neonatal mortality)(1)
- **Antenatal care (ANC):** is a type of preventive healthcare service aiming to provide regular check-ups that allow doctors or midwives to treat and prevent potential health problems throughout the course of the pregnancy and to promote healthy lifestyles that benefit both mother and child (WHO, 2005).
- **Infant mortality:** the probability of dying between birth and the first birthday(1,2)
- **Child mortality:** the probability of dying between the first and the fifth birthday(1,3)
- **Under-5 mortality:** the probability of dying between birth and the fifth birthday
- **Perinatal mortality rate:** is the sum of stillbirths and early neonatal deaths divided by the sum of all stillbirths and live births(1,3).
- **Maternal Health** :Refers to the health of a woman during pregnancy or within 42 days of termination of pregnancy, due to pregnancy related issues(4)
- **Child Health**: Refers to any health issues in children ages five years or less (WHO, 2016)
- **Community Health Workers**: Defined as "…members of the communities where they work, should be selected by the communities, should be answerable to the communities for their activities, should be supported by the health system but not necessarily a part of its organization, and have shorter training than professional workers" (4)
- **Prevention Interventions** or "measures adopted by or practiced on persons not currently feeling the effects of a disease [or negative health outcome], intended to decrease the risk that that disease [or negative health outcomes] will afflict them in the future" (4).

I. INTRODUCTION

I.1. BACKGROUND

Since the declaration of the Millennium Development Goals (MDGs), neonatal mortality has globally decreased in all corners, despite a slowest reduction in Africa and Asia compared to other parts of the world(3).Childhood mortality varies with socioeconomic conditions and may vary with children and their mother's demographic characteristics(1).

Globally, mortality among children under five is decreasing, but at the beginning of life, deat hs among these children are naturally concentrated.Most neonatal mortality is preventable an d accounts for 46% of total deaths among children below 5 years of age(5,6).Worldwide, neo natal death rates declined from 5.0 million in 1990 to 2.5 million in 2017.Approximately 7,00 0 neonatal deaths a day and almost 1 million deaths in 2017(5).Similarly, therewere risk of 2. 6 million newborns dying in their first month of life in 2016, the bulk of which happened in the first week of life(7).Neonatal mortality declined by41% over this period from 2000 to 2017 compared to infant mortality that reduced by 51%in the same period (5).

Children who die within the first month of life are mainly suffering from difficulties and conditionssuffering from difficulties and diseases related to lack of adequate birth care or skil ledcare and treatment immediately after birth and during the first days of life.Premature birth, intrapartumrelated complications (severe asphyxia or breathing failure at birth), infections an d birth defects are the main causes of neonatal death(3,8–10)

Although there is a global decrease in neonatal mortality rates, there are marked differences b etween regions and countries in neonatal mortality.Throughout SSA and South Asia, neonatal mortality is the highest regionally, with each reported 27 deaths per 1,000 live births through out 2017(11). Being born in SSA or in South Asia is more likely associated with dying at nine times more in the first month than a child born outside this location. Likewise, dying in the highest mortality country is about 50 times higher than in the lowest mortality country across countries (12–15)

Most of neonatal deaths, estimated to be 75%, occur in seven days of life. Around 1 million new-borns die within the first days(15).Intrapartum related complications(no cry at birth, loss of breathing), neonatal sepsis and birth defects resulted in loosing neonates within 28 days of life in 2016 (16–18).In general, difficulty in breathing, digestive disorders, congenital anomalies contribute to deaths of children under the age of five.

The quality of health care offered to pregnant women is a primary determinant in reducing neonatal deaths. Educated mothers, beneficiary of midwife-led continuity care are protected to loose their babies and to deliver the premature neonates (5).

The World Health Organization (WHO) recommends that every new-born undergo a postnatal care test within 24 h of birth, either in the facility, or after a home deliver y, with other three following visits in the first six weeks of life (WHO 2013).Although there has been an increasing in the number of attended deliveries by a skilled provider, increasing from 59 percent in 1990 to 80 percent in 2017 (WHO), neonatal follow up after birth continues to have the lowest coverage across the continuum of care(19).

Post-partum checkup for the baby and the mother is a significant occasion for checking the danger signs for mother and her baby. Occasionally, it is a time for health education by whichthe mothers receive advice on how to identify and respond to these danger symptoms, a s well as the benefits of exclusive breastfeeding and immunization(19,20).

By achieving the high level of quality antenatal care, skilled care at birth, postpartum check-ups for mother and baby, and care of small and sick new-borns(2), all can contribute in improving the neonatal survival level and end preventable stillbirths under support of facility level births, that is an excessive chance for giving essential new-born service and identify and manage high risk new-borns(3,9,21).

Rwanda's neonatal as well as infant deaths have experienced major declines through a commitment to strengthening the health care system and addressing barriers to access(22). These interventions have included expansion of community-based health insurance (CBHI), implementation of a community health worker (CHW) program capable of providing community-based combined management of infant illness, near universal coverage of childhood vaccinations, pregnant women immunization and a strengthened system of facility-based care.

In Rwanda, the CBHI scheme was designed to ensure that even the most vulnerable and marginalized do not encounter financial barriers to accessing the formal health system and to protect them from catastrophic costs. Policies surrounding CBHI were modified in 2012 to increase enrolment in more rural regions and among the poorest by prorating CBHI fees based on a family’s socioeconomic status. Although certain number of families live without or no full coverage with an insurance(22).The key role of CHWs in mobilization and sensitization

of households on suitable maternal and neonatal health practices plays in decreasing poor neonatal outcome(23).

I.2. PROBLEM STATEMENT

Neonatal mortality remains a problem for global and reginal health. Global neonatal mortality accounts for about 40% of all deaths among children under five (15), and local mortality rates are highest in Africa and Asia, estimated at 27 deaths per 1,000 live births in 2016. Such mortality is contributed to the poor-quality care at birth, combined with insufficient skilled health care services including treatment after birth upwards. The highest neonatal mortality rates were found in Western (and South) province at 25 deaths per 1,000 live births and, in Eastern province was the second having lower neonatal mortality rates at 22 deaths per 1,000 live births (1). No study conducted to analyse the similarity and difference of the risk factors for neonatal mortality among the Western and Eastern provinces of Rwanda in 2015.This study's aim was to identify the risk factors for neonatal mortality in each province, showing the similarity and the difference of the risk factors contributing to neonatal deaths. The study will suggest measures to assist the Rwandan society achieve the goal in reducing child mortality by focusing in contextual risk factors reduction.

I.3. RATIONALE

Under five children mortality rate is an important indicator for maternal and child health attention; specifically, a level of socio-demographic among the population under concern (WHO).

Both neonatal and infant mortality rates are carefully monitored measures of public health, representing children and communities ' access to basic health services such as ANC, health care provision, health education, treatment of infection and adequate nutritional support(9). The Western province was found having high neonatal mortality and eastern province had second province with low neonatal mortality(15,24,25). This study intends to analyse and compare the determinants of neonatal outcomes from the two provinces to elicit the key factors highly associated with the neonatal deaths in each or both province(s). The demonstration of these factors will support and demonstrate the factors to be focused in strategic public and community health planning and monitoring for achieving the sustainable development goals.

I.4. RESEARCH QUESTIONS

- What is the early neonatal mortality rate in Western and Eastern Provinces?
- What are the risk factors for neonatal mortality both in Eastern and Western Provinces of Rwanda according to RDHS 2014/15?
- What are the similar and different risk factors for neonatal mortality between Western and Eastern Provinces of Rwanda according to the RDHS 2014/15?

I.5. OBJECTIVES

1.5.1. Main objective

To compare risk factors for neonatal mortality in Eastern and Western Provinces of Rwanda.

1.5.2. Specific Objectives.

- To determine the rate of early neonatal mortality in both Eastern and Western Provinces according 2014/15
- To identify the risk factors for neonatal mortality in both Eastern and Western Provinces of Rwanda according to the RDHS 2014/15.
- To compare risk factors for neonatal mortality in Eastern and Western provinces of Rwanda according to the RDHS 2014/15.

II. LITERATURE REVIEW

The socioeconomic status of a nation as well as the quality of life of the population under research are reflected by both neonatal and infant mortality rates (11,26).Socioeconomic conditions affect child mortality, so this mortality can vary depending on the demographics of children and their families(1).

Globally, in 2017, infants died at rate of 18 deaths for 1,000 live births in their first 28 days of life. Approximately 14 million mothers aged 15 to 19 years of age give birth every year w orldwideThe number of adolescent births in SSA is particularly high with about 50% of moth ers under the age of 20.Adolescent mothers have a much higher risk of neonatal mortality co mpared to adults (27).

Factors reported in Kenya mostly likely associated with early neonatal mortality are: age of pregnancy, completed antenatal care visits, and delivery complications at birth among others (28).Many studies have shown in developing countries that physical proximity to antenatal ca re of the health facility(29) influences neonatal mortality.The other mainly related factors are: pregnancy domestic violence, pregnancy complications, mother's tetanus toxoid immunizatio n(TTI) for the mother (3,30).

Indeed, the other highlighted factors contributing to neonatal outcomes in different studies are postnatal care, place of delivery, delivery complications, breastfeeding within the first hour of delivery , birth weight, (30,31) , sex of the child, household wealth, maternal age group, as well as educational status of the mothers(2,15,29,30).

Adding, different factors in health care services, such as lack of at least two doses of tetanus toxoid vaccine during pregnancy, lack of breastfeeding within the first hour of birth, are foun d primarily in low- and middleincome countries as contributing factors to neonatal deaths (29,30).As shown by other research, small neonates with low birth weight were vulnerable to neonatal mortality relative to neonates with normal birth weight at birth(29).Certain research have explained that small for gestational age and low birth weight are associated with increas ed neonatal mortality risk (32).

There is a significantly augmented hazard of fetal death at 32 to 36 weeks of gestational age among women receiving the purposeful, reduced dose of ANC package (25). This is attributed in general to decreased antenatal visits, variations in environments, demogra phics and content and quality of care, as well as the timing of visits which might also play a role.

Achieving all four ANC visits, receiving a full complement of tailored, evidence based interventions is still important in reducing neonatal and maternal deaths, particularly in areas where few pregnant women attend antenatal care(25).The services must be tracked not only with regard to the number of visits, but also with regard to accurate treatment given and medi cally eloquent maternity(3,20–22).

The maternal age of 14-24 years was found to be more related with poor outcome among neonates(2). Research in Southwest Ethiopia showed that the majority of dead neonates were fromfamilies residing in rural areas, as mothers living in urban settings had better access to he althcare facilities, hence the positive neonatal outcome in urban settings(3).

Interestingly, the analysis of the relationship between antenatal care attendance and neonatal mortality in low- and middleincome countries (LMICs) showed a small risk of neonatal mort ality between pregnant women who followed all antenatal care guidelines of the WHO, excep t in the Middle East and North African regions where there was no difference(15).

The function of the ANC is demonstrated by a 32% reduction in risk of neonatal mortality am ong pregnant women who completed at least one WHO recommendation in LMICs, the great er risk of neonatal death during the early neonatal period, and this was comparable to numero us earlier studies which explored the risk factors of neonatal mortality in certain LMICs(8,15, 33,34).It has been shown in Ghana that remaining in rural areas with a high prevalence of ana lphabetism, poverty and unemployment is positively related to neonatal results (31).

Most earlier LMIC studies showed that being born as a child of multiple pregnancies is negati vely associated with neonatal survival(15,31).In Uganda, the study of neonatal mortality in ru ral communities and its determinants showed that pregnant women who completed four ANC visits and/or were visited by community health workers (CHWs) were less likely to lose their newborns(23).Less than 2.5Kg neonates, are known as low birth weight babies, (predisposing them to increased risk of infection, low blood sugar and low body temperature) is mostly known as a poor indicator associated with higher risk of neonatal mortality compare d to normal newborns in various studies (2,23,32).

Likewise, research in Pakistan, one of the low-income countries has also shown that under-standard care, inadequate training, low skills in personnel and lack of resources, including eq uipment and medication, lead to neonatal death(23).In contrast to these challenges, the lack of

focus on postnatal services puts homeborn neonates in ' ' double risk " due to reduced intrapa rtum care performance and inadequate access to postnatal care(19)
A research in Zambia showed that midwives who delivered regular homebased PNC at three, seven, 28, and 42 days after delivery increased women's ability to recognise risks between ne wborns and use health services more often than women who received less PNC visits(20).In African countries, such as Uganda and Zambia, several mothers have reported positive experi ences with postnatal care, but postnatal care is also interrupted or withheld (19).

In Rwanda, according to the recent Rwanda Demographic and Health Survey in 2014/2015 (RDHS 2014/15), neonatal mortality is 20 deaths per 1,000 live births(1), whereas the preceding RDHS showed neonatal mortality to be 27 death per 1,000 live births and 37 death per 1,000 live births in 2010 and 2005 respectively(1).
This 2014/15 RDHS found that antenatal treatment was attended by a large number of pregna nt women (99 percent),44 percent of them completed four or morevisits.Ninetyone percent ga ve birth at health facilities (1) while within the first fortyeight hours after birth, 19 percent of all live births benefited from a followup or postnatal care facility.The associated factors that h ave influenced this postnatal care are primarily birth order, place of delivery, maternal age an d level of education, or wealth index (1).

In the same survey, countrywide, the mothers reported that the small children are nearly four times as likely to die before 28 days of life compared to children with average or larger weight(1).Newborns whose mothers are highly educated are less likely to die in their earlier li ves than children whose mothers are less educated or uneducated; in addition, there are other factors that contribute to neonatal deaths such as too young or too old maternal age, a short bi rth interval (less than two years after the preceding birth), and high parity (more than three pr egnancies) or high parity(1).However, another in Rwanda found that there is a large proportio n of the remaining deaths at home, with home deliveries still being a significant risk factor fo r neonatal death, with 31.0 percent of the deaths of neonates at home(35)

III. METHODOLOGY

III.1. Study setting

Rwanda has a population of approximately 12.3 million in East Africa (36). Rwanda is a state of 26,338 km2 with a thousand mounts. Rwanda has one town with four provinces. Rwanda has 30, 416 districts, 2,148 cells and 14,837 villages(37).The Eastern and Western provinces, respectively, share borders with Tanzania and the Democratic Republic of Congo. The health system in Rwanda (26) comprises five levels: community level, healthpost level, health cente r level, district hospital level and hospital tier of referral / teachinghospitals level.

Community health workers (CHWs) provide household level health education, case identifica tion for acute and chronic illness, integrated community case management, including diagnos is and treatment of pneumonia, diarrhea, and malaria), female contraceptives, and referral to health facilities for prenatal care, deliveries, and other medical services.
Every health center serves a catchment area of about 20,000to30,000 residents and is staffed by general nurses providing basic diagnostics, emergency outpatient services, family plannin g, prenatal care, and regular delivery

In most districts, the average walking distance to the nearest health facility from households i s estimated at just over an hour.In keeping with national standards, district hospitals in the Ea stern and Western Provinces are staffed by general practitioners and nurses who provide seco ndary care for patients referred from health centres, including extensive obstetric emergencies requiringcesarean section, neonatal care and hospital treatment for serious infant infection and extreme malnutrition

III.2. Study design

The study used RDHS 2014/2015 secondary data to compare neonatal mortality risk factors i n Rwanda's eastern and western provinces. This study used quantitative and analytical approa ches as a cross-sectional analysis

III.3. Target population

The target population was all 28 days or less of age neonates in the Eastern and Western provinces of Rwanda within the year 2014/2015 of survey.

III.4. Sampling methodology

III.4.1. Sample size

For recruiting study participants, this RDHS 2014/15 used stratified two stage cluster sampling(1).The first stage consisted of selecting clusters from each stratum (district).

The second stage was a systematic sampling of households chosen from each group.They then visited and interviewed selected households.The original survey identified the qualified households with neonates and infants.

This current study therefore analyzed a total of 6016 live births (neonates) from the Easte rn and Western provinces (included in the 2014/15 RDHS) as the total sample of the stud y. The study was based on mothers who remained in the households on the night preceding the interview.

III.4.2. Inclusion and Exclusion criteria

Inclusion criteria

- Women aged 15-49 years who had delivered live births within the two years preceding the survey.
- Mothers who remained in the households on the night preceding the interview.

Exclusion criteria's

- Women aged 15-49 years who had not delivered live births within the two years preceding the survey.
- Mothers who did not remain in the households on the night preceding the interview

III.4.3. Data collection procedures and tools.

Data collection procedures

For this analysis, secondary data was used. They were gotten from RDHS that was conducted from November 9, 2014 to April 8, 2015. A registration and application to RDHS data was made to use the data and was approved on December26th, 2018. Data for the Eastern and Western provinces have been extracted from the RDHS 2014/15 data set after obtaining factors of neonatal mortality within the whole country of Rwanda.

The data to analyse the neonatal outcome is extracted from the section of the Woman's Questionnaire used in DHS 2014/2015. In this section of the questionnaire, every interviewed woman age 15-49 shared her demographic and health information focusing on pregnancy and birth history.

Study tools

Data from both Eastern and western province was analyzed using STATA version 13.0.

III.5. Study variables.

Outcomes variable: Outcome variable is neonatal mortality. If the neonate was dead within 28 days after birth (yes/no).

Independent variable: The independent variables were: having a first and second PNC check on the first and third day of life respectively (yes/no). In addition to the PNC variables, we studied available maternal health variables relevant to our outcome variable: receipt of tetanus toxoid (before delivery: yes/no), number of ANC visits(<=1, >1) , if new- born was ever breastfed(yes, no), mode of delivery (Caesarean section or not)and location of delivery(health facility or not). Information on child gender (Male/female), birth weight (LBW, Normal weight, HBW), birth order (1^{st}, 2^{nd}-4^{th}, 5^{th} +), and gestational age (term, non-term) were also included in our analysis.

Probable confounding variables that were considered are: The socio-demographic confounding variables like maternal age in years, parity, education (no education, primary, secondary, secondary), residence(rural/urban), maternal marital status and wealth quintile. Those socio-demographic variables were chosen based on the literature and all were included in the regression models as control variables.

The following figure (Fig.1) shows the framework illustrating the key determinants that could contribute to neonatal mortality in this study in Rwanda. This conceptual framework for determinants of neonatal mortality, adapted from Mosley and Chen conceptual frame for child survival in developing countries(38), has been developed based on the available information in the 2014/2015 RDHS dataset.

In Socioeconomic (also named community) factors, we prioritized residence, religion, maternal education, head of household age, household wealth index. Individual and health related factors were illustrated among the factors contributing to neonatal mortality. Among them, maternal (parity, age, birth interval, first breastfeeding time, mode and location for delivery) and child factors (birth order, birth weight, sex) were focused. Antenatal care, intrapartum and post-partum determinants are considered to influence the neonatal outcome.

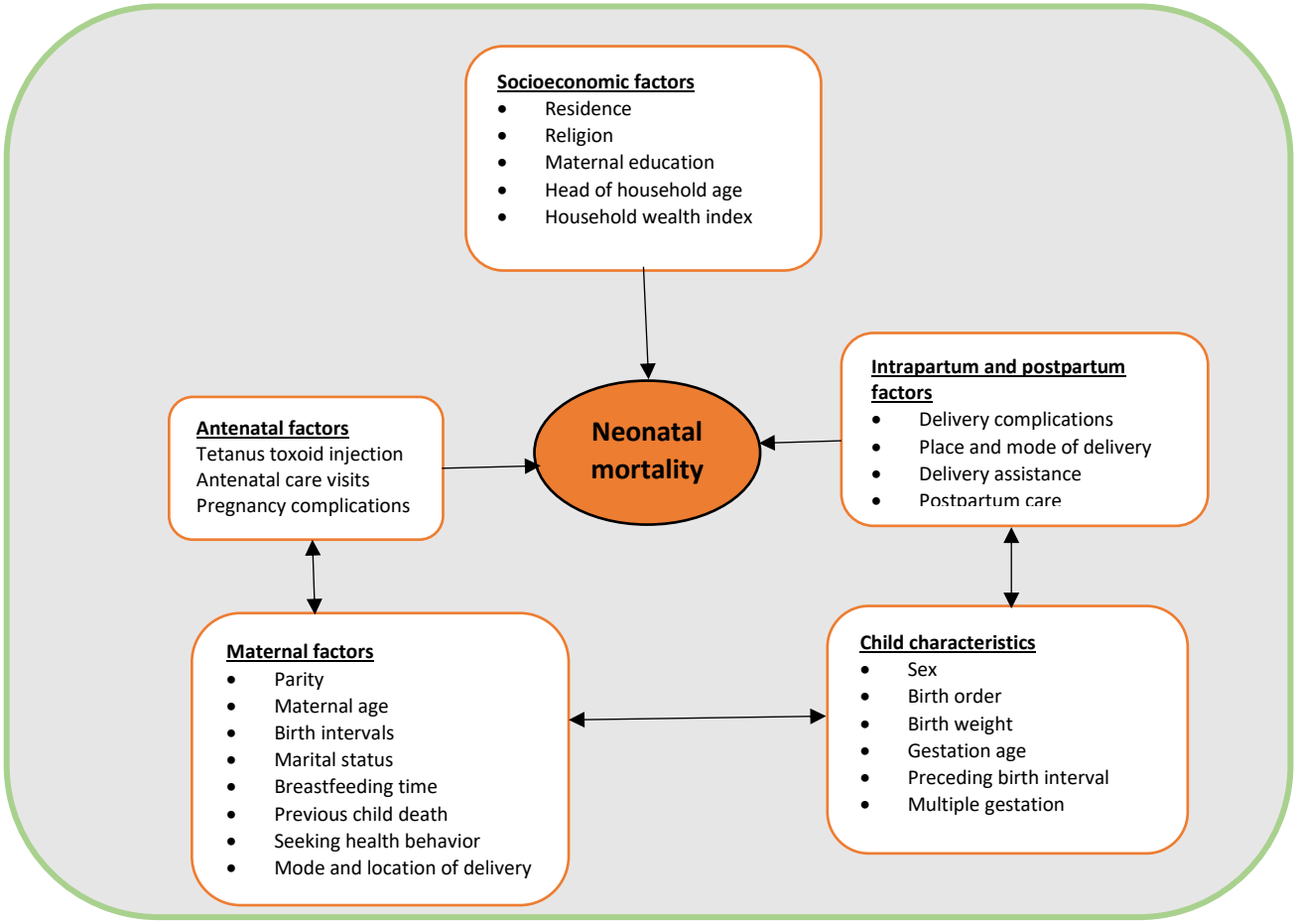

Fig.1.*Theoretical model for neonatal mortality determinants, adapted from the conceptual framework of Mosley and Chen for infant s urvival in developing countries*

III.6. Data analysis

We extracted variables and values of interest from the RDHS 2014/15 dataset to get data of both Eastern and Western provinces. Then, we renamed some variables and proceed with analysis of neonatal health status as categorical variable. STATA 13.0 was used to display results according significance of comparative factors.

Descriptive analysis for respondents and children characteristics were computed for the two provinces. Bivariate and multiple logistic regressions were used to show comparative risk factors for neonatal mortality in the Eastern and Western Provinces of Rwanda. Analysis was based at a significance level of 0.05 and 80% power. The first step was to group the measures that defines neonatal death after defining them. After this, we determined the percentages and compare neonatal death/mortality risk factors in the Eastern and Western provinces. As we had a categorical outcome variable, the odd ratios were calculated for displaying the associated factors to neonatal outcome in this population under study.

Dissemination / publications

Findings from the study will be shared with the School of Public health University of Rwanda and later will be published in a peer reviewed journal.

Policy implications

The results will be used to strengthen existing knowledge on Risk factors for neonatal mortality in Rwanda, especially in the two provinces under study, hence contributing in child reduction policy reforms focusing on contextual risk factors towards the achievement of the sustainable development goal by 2030.

ETHICAL CONSIDERATION

Confidentiality: The personal details of participants were not requested to the DHS team when applying for the dataset. The researchers that participated in the RDHS 2014/15 did not participate in the present study and we will not make any efforts to identify the study participants. The study data were analyzed anonymously.

Informed consent/Assent form: This study had no direct contact with humans nor with any identifiable information/parts of human beings. The researcher found no need for an informed consent for participation, hence no informed consent was needed.

IV. RESULTS

IV.1. Socio-economic and health characteristics of the study population

Over 83% of the baby's mothers were living in rural area, and 14.78% had no formal education. Fifty-three per cent of children were of fifth and above birth order, 64.79% were born with high birth weight (very large at birth) and 58.24% were firstly breastfed after the first hour of birth time. Mothers who received more than one tetanus toxoid injection during pregnancy were 68.12%, and 73.65% had started the ANC with the pregnancy of more than three months.

Table 1.a: Key socio-economic and health factors of the study population for RDHS 2014/15 (Western and Eastern provinces)

Socioeconomic Characteristics	**Total births**	
	(N)	**(%)**
Province		
West	3060	50.8
East	2956	49.2
Mothers' age group		
<= 21	1664	27.66
22-40	3505	58.26
41-59	847	14.08
Children gender		
Male	2083	51.39
Female	1970	48.61
Head of household age group		
<= 35	2146	36.28
36-50	2282	38.58
51+	1487	25.14
Residence		
Rural	5042	83.81
Urban	974	16.19
Mothers' education level		
No education	889	14.78
Primary	3856	64.10
Secondary	1152	19.15
Higher	119	1.98
Religion		
Adventist	769	12.80
Roman Catholic	2000	33.28
Protestant	3040	50.58
Jehovah witness	51	0.85
Muslim	131	2.18
No religion	17	0.28
Wealth Index		
Poorest	1224	20.35
Poorer	1314	21.84
Middle	1275	21.19
Richer	1209	20.10
Richest	994	16.52
Child birth order		
1^{st}	868	14.43
2^{rd} -4^{th}	1938	32.21
5^{th} +	3210	53.36
Health Characteristics		
Delivered by caesarean section		
Yes	370	12.80
No	2891	87.20
Number of tetanus toxoid injection received before delivery		
One or zero injection	1918	31.88
More than one injection	4098	68.12
ANC started at pregnancy of		
<= 3 months	1585	26.35
>3 months	4431	73.65

Table 1.a. Key socio-economic and health factors of the study population for RDHS 2014/15 (Western and Eastern provinces), *Continued*

Health Characteristics	Total births	
	(N)	(%)
Number of ANC visits completed		
One or zero ANC visit	132	2.19
2-3 visits	1576	26.20
4 visits	4308	71.61
Birth weight		
LBW	151	2.51
Normal birth weight	1967	32.70
HBW (very large)	3898	64.79
Start of breast feeding		
Within first hour after birth	2,512	41.76
After the first hour of birth	3,504	58.24
Was Child died d within 7 days of life after birth?		
Yes	52	91.2%
No	7	8.8%

IV.2. Neonatal Mortality rates

Overall live births (n=6 016), there were 3060 (50.8percent) from Western province and 2956 (49.2 percent) in Eastern province. The dead neonates from birth day to 28th day were 57, whom 91.2% died within seven days after birth, (Table1, Figure 1).

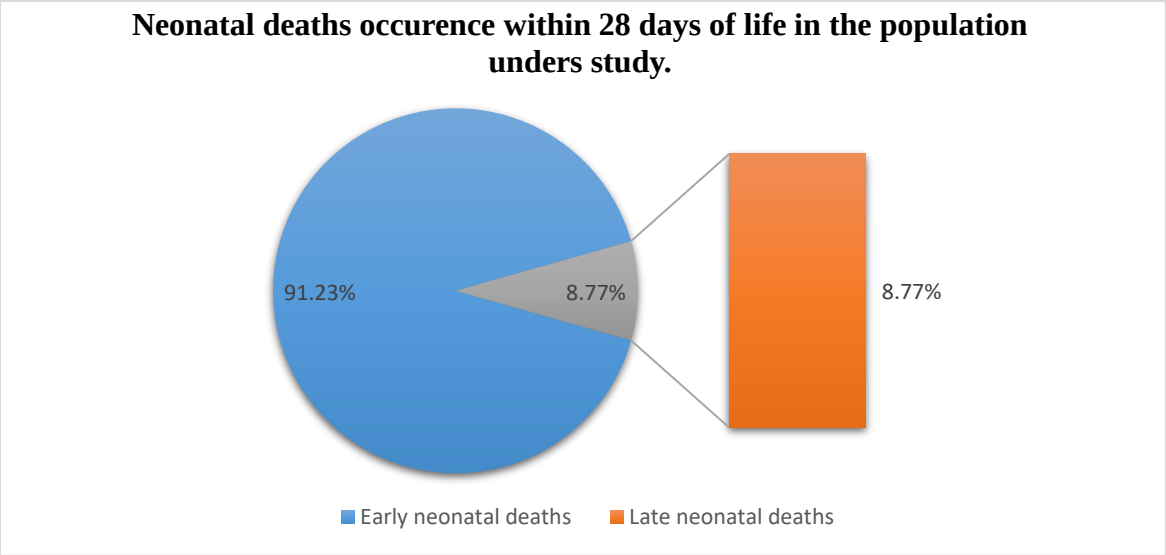

Fig 2: Comparison of early and late neonatal deaths among the population under study, RDH 2014/15

IV.3. Risk factors for neonatal mortality

The distribution of neonatal mortality by background characteristics is shown in Table 2 of bivariate analysis to show up the factors associated with the neonatal death from each province.

Table 2: Comparative bivariate analysis of the determinants of neonatal deaths from the population under study using RDHS 2014/15

Socioeconomic Characteristics	Total live births(N)	Neonatal deaths					
		Western province			Eastern province		
		Prevalence n (%)	X^2	*p*	Prevalence n (%)	X^2	*p*
Mothers' age group							
<= 21	1664	5 (17.24)	16.3138	0.000	2 (7.14)	18.5131	0.000
22-40	3505	13 (44.83)			14 (50.00)		
41-59	847	11 (37.93)			12 (42.86)		
Children gender							
Male	2083	18 (62.07)	1.5874	0.208	21 (75.00)	5.8753	0.015
Female	1970	11 (37.93)			7 (25.0)		
Head of household age group							
<= 35	2146	6 (21.43)	18.09	0.000	4 (14.29)	6.5672	0.037
36-50	2282	21 (75.00)			14 (50.00)		
51+	1487	1 (3.57)			10 (35.71)		
Residence							
Rural	5042	19 (65.52)	4.8292	0.028	26 (92.86)	1.0113	0.315
Urban	974	10 (34.48)			2 (7.14)		
Mothers' education level							
No education	889	6 (20.69)	10.2198	0.017	6 (21.43)	1.6142	0.656
Primary	3856	21 (72.41)			18 (64.29)		
Secondary	1152	0 (0.00)			4 (14.29)		
Higher	119	2 (6.90)			0 (0.00)		
Religion							
Adventist	769	2 (7.14)	4.2109	0.519	1 (3.57)	6.4083	0.379
Roman Catholic	2000	10 (35.71)			13 (46.43)		
Protestant	3040	14 (50.00)			12 (42.86)		
Jehovah witness	51	1 (3.57)			1 (3.57)		
Muslim	131	1 (3.57)			1 (3.57)		
	17	0 (0.00)			0 (0.00)		
Wealth Index							
Poorest	1224	3 (10.34)	3.8290	0.430	4 (14.29)	1.0780	0.898
Poorer	1314	7 (24.14)			7 (25.0)		
Middle	1275	7 (24.14)			7 (25.0)		
Richer	1209	6 (20.69)			7 (25.0)		
Richest	994	6 (20.69)			3 (10.71)		
Child birth order							
1st	868	6 (20.69)	3.8578	0.145	7 (25.0)	2.3140	0.314
2rd -4th	1938	12 (41.38)			7 (25.0)		
5th +	3210	11 (37.93)			14 (50.0)		
Health characteristics							
Delivered by caesarean section							
Yes	370	5 (31.25)	5.0817	0.024	5 (27.78)	3.5514	0.059
No	2891	11 (68.75)			13 (72.22)		
Number of tetanus toxoid injection received before delivery							
One or zero injection	1918	13 (44.83)	3.6552	0.056	15 (53.57)	4.2610	0.039
More than one injection	4098	16 (55.17)			13 (46.43)		
ANC started at pregnancy of							
<= 3 months	1585	6 (20.69)	0.2617	0.609	8 (28.57)	0.005	0.944
>3 months	4431	23 (79.31)			20 (71.43)		
Number of ANC visits completed							
<=1 visit	132	2 (6.90)	3.7871	0.151	2 (7.14)	4.7876	0.091
2-3 visits	1576	8 (27.59)			11 (39.29)		
4 visits	4308	19 (65.52)			15 (53.57)		
Birth weight							
LBW	151	3 (10.34)	14.1155	0.001	2 (7.14)	2.1458	0.342
Normal birth weight	1967	4 (13.79)			11 (39.29)		
HBW (very large)	3898	22 (75.86)			15 (53.57)		
Start of breast feeding							
Within first hour after birth	2,512	4 (13.79)	7.4064	0.006	7 (25.00)	4.7454	0.029
After the first hour of birth	3,504	25 (86.21)			21 (75.00)		

From this above table two, Mothers' age group (X^2:16.3138, *p* value:0.000), head of household age group (X^2:18.09, *p* value:0.000), residence (X^2:4.8292, *p* value:0.028), mother' education level (X^2:10.2198, *p* value:0.017),model of delivery (X^2:5.0817, *p* value:0.024),birth weight (X^2:14.1155, *p* value:0.001),time of starting breastfeeding (X^2:7.4064, *p* value:0.006) are the predictors factors for the neonatal survival outcomes in western province; and the associated factors to neonates survival status in eastern province are Mothers' age group (X^2:18.5131, *p* value:0.000), child gender , (X^2:5.8753, *p* value:0.015), head of household age group(X^2:6.5672, *p* value:0.037),Number of tetanus toxoid injection s (X^2:4.2610, *p* value:0.039) and time of starting breastfeeding(X^2:4.7454, *p* value:0.029).

The odds ratio of the possible factors associated with neonatal mortality, a result from a multivariate logistic regression are shown in Table 3. The factors associated with neonatal mortality in the population under this study were: residing in rural area, born with normal and high birth weight, mother's age group of 41-58, child birth order, number of tetanus toxoid injection, birth weight, head of household age group of 36-50 years.

The outcome of neonatal mortality showed statistically to be more likely(significant) associated with residing in rural area (*OR*= 2.30 ,95% CI : 1.07-5.010) in both province, 5^{th} and above birth order (OR=4.78, 95% CI : 1.632-14.047), more than one tetanus toxoid injection (OR:2.1 , 95% CI:1.021-4.546) in eastern province, and both normal birth weight (OR: 12.9 ,95%CI =2.826-59.211) , high birth weight (OR: 4.9, 95% CI : 1.422-16.823) in western province.

On other hand, the predictors factors less likely associated with the neonatal outcomes are: mother's age group of 41-58 (OR:0.20 ,95% CI=0.067-0.58) linked to the reference mother's age group of <= 21 years, Head of household age group of 36-50 years (OR: 0.29 ,95%CI=0.118-0.734) related to the reference head of household age group of <= 35 years, starting breastfeeding after first hour of birth (OR: 0.25 95% CI=0.088 - 0.737) in both provinces; delivery by a caesarian section(OR: 0.31 95% CI=0.107-0.908) linked to a non-caesarian section as mode of delivery in Western province.

Table 3: Multilevel analysis of the factors associated with neonatal deaths in the two provinces

Socioeconomic Characteristics	Total live births(N)	Neonatal deaths					
		Western province			Eastern province		
		Prevalence n (%)	*OR (95%CI)*	*p*	Prevalence n (%)	*OR (95%CI)*	*p*
Mothers' age group							
<= 21	1664	5 (17.24)	1		2 (7.14)	1	
22-40	3505	13 (44.83)	0.78 (0.276-2.189)	0.634	14 (50.00)	0.77 (0.276-2.180)	0.634
41-59	847	11 (37.93)	0.20 (0.067-0.581)	0.003	12 (42.86)	0.20 (0.069-0.58)	0.003
Children gender							
Male	2083	18 (62.07)	1		21 (75.00)	1	
Female	1970	11 (37.93)	1.62 (0.760-3.443)	0.212	7 (25.0)	1.62 (0.760-3.443)	0.212
Head of household age group							
<= 35	2146	6 (21.43)	1		4 (14.29)	1	
36-50	2282	21 (75.00)	0.29 (0.118-0.734)	0.009	14 (50.00)	0.29 (0.118-0.734)	0.009
51+	1487	1 (3.57)	4.50 (0.0548-38.26)	0.160	10 (35.71)	4.56 (0.548-38.026)	0.160
Residence							
Rural	5042	19 (65.52)	2.30 (1.07-5.010)	0.033	26 (92.86)	2.32 (1.071-5.010)	0.033
Urban	974	10 (34.48)	1		2 (7.14)	1	
Mothers' education level							
No education	889	6 (20.69)	1		6 (21.43)	1	
Primary	3856	21 (72.41)	1.20 (0.482-2.996)	0.692	18 (64.29)	1.50 (0.592-3.804)	0.392
Secondary	1152	0 (0.00)	1	-	4 (14.29)	1.80 (0.516- 6.565)	0.347
Higher	119	2 (6.90)	0.42 (0.082-2.126)	0.294	0 (0.00)	-	-
Religion							
Adventist	769	10 (35.71)	1		13 (46.43)	1	
Roman Catholic	2000	2 (7.14)	2.24 (0.489-10.274)	0.299	1 (3.57)	2.24 (0.489-10.274)	0.299
Protestant	3040	14 (50.00)	1.05 (0.464-2.375)	0.905	12 (42.86)	1.05 (0.465-2.375)	0.905
Jehovah witness	51	1 (3.57)	0.27 (0.034-2.245)	0.434	1 (3.57)	0.27 (0.034-2.245)	0.230
Muslim	131	1 (3.57)	0.44 (0.054-3.485)	0.434	1 (3.57)	0.43 (0.056-3.485)	0.434
No Religion	17	0 (0.00)			0 (0.00)		
Wealth Index							
Poorest	1224	3 (10.34)	1		4 (14.29)	1	
Poorer	1314	7 (24.14)	0.38 (0.099- 1.505)	0.171	7 (25.0)	0.39 (0.099-1.505)	0.171
Middle	1275	7 (24.14)	0.32 (0.0826-1.247)	0.101	7 (25.0)	0.32 (0.082-1.247)	0.101
Richer	1209	6 (20.69)	0.31 (0.078-1.270)	0.105	7 (25.0)	0.31 (0.078-1.270)	0.105
Richest	994	6 (20.69)	0.30 (0.075- 1.223)	0.094	3 (10.71)	0.30 (0.075-1.223)	0.094
Child birth order							
1st	868	6 (20.69)	1		7 (25.0)	1	
2rd -4th	1938	12 (41.38)	1.14 (0.836-6.190)	0.786	7 (25.0)	1.75 (0.640-4.816)	0.274
5th +	3210	11 (37.93)	2.27 (0.83-6.190)	0.107	14 (50.0)	4.78 (1.632-14.047)	0.004
Health characteristics							
Delivered by caesarean section							
Yes	370	5 (31.25)	0.31 (0.107-0.908)	0.033	5 (27.78)	0.38 (0.134-1.079)	0.069
No	2891	11 (68.75)	1		13 (72.22)	1	
Number of tetanus toxoid injection received before delivery							
One or zero injection	1918	13 (44.83)	1		15 (53.57)	1	
More than one injection	4098	16 (55.17)	2.02 (0.968-4.220)	0.061	13 (46.43)	2.1 (1.021-4.546)	0.044
ANC started at pregnancy of							
<= 3 months	1585	6 (20.69)	1		8 (28.57)	1	
>3 months	4431	23 (79.31)	1.26 (0.053-3.118)	0.610	20 (71.43)	1.2 (0.513-3.118)	0.610
Number of ANC visits completed							
<=1 visit	132	2 (6.90)	1		2 (7.14)	1	
2-3 visits	1576	8 (27.59)	2.84 (0.59-13.678)	0.192	11 (39.29)	2.8 (0.59-13.67)	0.192
4 visits	4308	19 (65.52)	3.84 (0.87-16.86)	0.074	15 (53.57)	3.8 (0.87-16.86)	0.074
Birth weight							
LBW	151	3 (10.34)	1		2 (7.14)	1	
Normal birth weight	1967	4 (13.79)	12.9 (2.826-59.211)	0.001	11 (39.29)	1.9 (0.434-9.125)	0.375
HBW (very large)	3898	22 (75.86)	4.9 (1.422-16.823)	0.012	15 (53.57)	2.7 (0.618-12.180)	0.184
Start of breast feeding							
Within first hour after birth	2,512	4 (13.79)	1		7 (25.00)	1	
After the first hour of birth	3,504	25 (86.21)	0.25 (0.088-0.737)	0.012	21 (75.00)	0.39 (0.168-0.938)	0.035

Table 4: Summary of Factors and their association with Neonatal Mortality according Province

List of studied factors	Factors **associated** with Neonatal Mortality		Factors **not associated** with Neonatal Mortality	
	Western Province	Eastern Province	Western Province	Eastern Province
Mothers' age group	Yes	yes		
Children gender			Yes	Yes
Head of household age group	Yes	Yes		
Residence	Yes	Yes		
Mothers' education level			Yes	Yes
Religion			Yes	Yes
Wealth index			Yes	Yes
Birth order	No	Yes		
Delivered by caesarean section	Yes	No		
Number of tetanus toxoid injection received before delivery	No	Yes		
ANC started at pregnancy of			Yes	Yes
Number of ANC visits completed				
Birth weight	Yes	No		
Time breastfeeding started	Yes	Yes		

DISCUSSION

In this study, 52 (91.2%) out of 57 died neonates occurred within the first week of life. This is in line with other prior studies in which more than three quarter of neonatal deaths occurred in the first week of life(2,7,24,30,31);specifically, different studies in Africa have shown that the majority (75 %) of the new-born deaths are found to occur in the first week of life, and around 44 % of which occur on the day of delivery within six hours(23). The explanation of this mortality could be majority of neonatal mortality in developing countries are related to conditions of labor, intrapartum and the immediate newborn care follow up and practices. Moreover, the major causes of death known are birth asphyxia, early neonatal infections and prematurity. This again clearly pointed out that neonatal survival interventions must target the immediate and early neonatal periods.

We found that living in rural area in both provinces, born with normal and high birth weight in western province, being of 5^{th} or above birth order, number of tetanus toxoid injection in eastern province were associated with higher likelihood of early neonatal mortality although there was an enough antenatal care attendance as one of the core determinants of neonatal mortality in this population. On other hand, mother's age group of 41 or above, head of household age group of 36 or above, starting breastfeeding after first hour of birth in both provinces, delivery by a caesarian section in western province had a protective effect against early neonatal mortality.

The determinants of neonatal mortality were most prominent in rural population in two provinces of Rwanda. The current study findings are like the findings of a study in Southwest of Ethiopia that showed that most of dead neonates were from families residing in rural area. Similarly, an analysis done by UNICEF shows that lower household wealth, an uneducated mother and birth in rural areas lower a newborn's chances of survival within the first 28 days of life(11).

The reason behind could be, as the mothers living in urban setting had an acceptable access to health services, including maternal and new-born services; thus, the neonatal mortality is low in urban setting. The concentration of this burden of neonatal mortality in rural groups may be a further indicator of poor socio-economic status combined with insufficient accessibility to maternal and child health care services in this part country.

Socioeconomically, mother's age (41-58 age group), age of household head (36-50 years) had a protective effect against neonatal mortality in the two provinces, and this finding is similar

to the findings of different studies(8,40).A common supporting argument is that increased both maternal age and age head of household increases mother's and household head's knowledge about child health and health care services and thereby improves health care seeking behaviors for their children and themselves.

Previous studies have shown that, the neonates with small in size at birth and small for gestational age and low birth weight are at an increased risk of death compared with neonates with normal birth weight at birth(30,32). This death is associated with an increased risk of infections, low blood sugar and low body temperatures that are mostly common for premature babies(32). This analysis found the opposite as the multilevel analysis showed that babies born with normal and high birth weights in western province were at high risk of dying in neonatal period than the live birth born with low birth weight. Since children are not often weighed at birth in some study settings (following the home deliveries on that time), mothers' report of the size/ weight of baby at birth would possibly be misclassified.

Several studies from developing countries have shown that a good neonatal outcome is influenced by different factors including breastfeeding within the first hour of delivery (30,31). Contrary, this analysis of RDHS 2014/15 found that starting breastfeeding after first hour of birth in both provinces was less like associated with neonatal death. This could be justified by a significant number of neonates that die so early without breastfeeding, and the observed association between breastfeeding and neonatal mortality might have resulted in an overestimation of the true association.

The influence of the 5^{th} or above birth order was associated with higher odds of neonatal deaths than neonates with first to fourth birth order. This can be associated with the high risk of occurrence of pregnancy and deliver complications among the grand multiparous mothers. This is similar to the findings of Gurmesa Tura et al in Ethiopia (3). This result may also suggest the presence of unmeasured factors. There are possible arbitrating factors not measured such as family size; health insurance, health services accessibility, place of delivery that may expose the large family on poor health neonatal outcomes among other health outcomes.

The previous studies showed that there is a strong association between neonatal outcome with sex of the child, previous history of neonatal death, household wealth, and educational status of the mothers(2,15,29,30).Contrary, this study found that sex of neonates, mother's education level, wealth index and number of ANC visits were not statistically associated with the neonatal deaths in both provinces.

Different studies showed that neonates born to mothers who have not received or received a single dose of tetanus toxoid injection (TTI) were more likely to experience neonatal death than those neonates born to mothers who received two or more doses of TTI (2,3,9,10,25) . Contrary, this current analysis, in eastern province, the neonates whose mothers had received more than one tetanus toxoid injection were most likely to die within 28 days of life. This finding suggests the presence of unmeasured factors. There are possible mediating factors not measured such as the dose of vaccine, the intervals between different tetanus toxoid injections, the respect of TTI appointments.

LIMITATIONS

This study is not free from limitations. Information collected in the DHS 2014/15 for neonatal/infants health were based on recall information in order to have neonatal mortality calculated, hence, liable to recall bias. Furthermore, in a community- based retrospective study like this, it is impossible to have data on some important variables. In the current study, we failed to analyze completely some other data on key important variables such as postnatal care time, sex of child, type of health care provider who assisted the mother during delivery, where the ANC was provided because of missing data. Likewise, pregnancy and delivery complications, neonates monitoring after birth (like temperature to detect the hypothermia, one of the factors contributing to neonatal death), neonatal health conditions, causes of death, and maternal nutrition, as those variables were not recorded, and consequently could not be evaluated as determinants of neonatal mortality.

CONCLUSION

In conclusion, we have reported moderate burden of neonatal mortality in the two provinces and associated determinants in this population. This problem may be an indicator to either failures in past child survival strategies or limitations in existing system responses. The child survival strategies in Rwanda are determined by global agenda and are not only complex but they also use multiple approaches that may not be driven by local contexts such as this population-based data to inform the interventions.

This study deeply identified different determinants of neonatal mortality in each province, which can serve to continuously design strategies for decreasing neonatal mortality. Health care related factors such as first breastfeeding time remains among the key determinants of neonatal mortality in both provinces; mode of delivery and tetanus toxoid injection during pregnancy in western province and eastern province respectively. Evidence of the effectiveness of community–based approaches to improve the health of mothers, newborns, and children in geographically defined populations is plentiful. Although Rwanda is arguably among the best recent examples showing the benefits for the health of mothers, newborns, and children by deploying CHWs to expand the population coverage of evidence–based interventions, however, major challenges remain in achieving high levels of coverage of these interventions, especially in rural area.

The burden observed among predominantly rural suggest a need to refocus, mainly on the socioeconomic determinants like residence, mother's age, mothers'/girls' education that must be refocused during planning strategies, targeting the increase of the health services accessibility in-hard to reach and/or the vulnerable rural areas and re-package strategies to target selected populations. The health communication for behavior change could target the middle and high mother's age groups, the grand multiparous mothers that are more likely associated with poor neonatal outcomes. Ensuring the continuum of care from pregnancy through delivery to the immediate postnatal period should be improved and focused to address neonatal mortality in the study area. Specifically, the continuous improvement of quality of health services provision, decentralization of key maternal and neonatal services packages focusing on rural areas are of the key importance to continuously decrease the neonatal mortality.

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ANNEX1

RWANDA DEMOGRAPHIC AND HEALTH SURVEYS 2014-15

WOMAN'S QUESTIONNAIRE