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Research Article

Modeling the Risks Factors Associated with Infant Mortality in Rwanda from 2011 to 2015: Analysis of Rwanda Demographic and Health Survey (RDHS) 2014/2015

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Abstract

Objective: The study aimed at building a model of infant mortality and its associated risk factors in Rwanda from 2011 to 2015.

Method: Cross-sectional survey was conducted using data from 2014/2015 Rwanda Demographic and Health Survey. Target population was women aged 15-49 years from sampled households. All 492 of the clusters selected were surveyed for 2014/2015 RDHS. STATA version 13 was used to analyse the statistical data.

Results: Infants from rural areas were 1.54 times more likely to die than in urban areas. Infants born to women aged 14-19 and 20-29 had [OR=1.23(0.62-2.42; OR=1.23(0.78-1.33)] respectively, were at high risk of death compared to other age groups. Males had 1.15 times higher risk of dying than females. Infants who were not breastfed were 1.98 times more likely to die compared to those who were breastfed. The women aged 30-34 had [OR=0.69(0.54-0.89)], 35-39 was [OR=0.43(0.4-0.46)], 40-44 was [OR=0.06(0.057-0.062)] and 45-49 [OR=0.22(0.21-0.23)]. IM was higher in males [OR=1.15(1.07-1.23)].

Conclusion: The factors associated with IM were grouped into community, ecological, socio-economic and proximate factors and identified that each group consists of multifactor that influence the infant mortality rate.

Keywords: Infant mortality; Modeling; Logistic regression; Proximate

Introduction

Infant Mortality (IM) is the death of children before they reach one-year-old [1]. Globally, infant mortality is the public health concern [2]. Around 4.6 million deaths occur annually during infancy, 99% of which occurs are from Lower Middle Income Countries (LMICs) [3]. Infant mortality rate is considered to be an important indicator of socioeconomic welfare of nations. Preceding studies indicate that 10 million infants die each year in developing countries, an estimated 10-20% of all infants die before their first birthday, and black infants continue to die at twice the rate of white infants [4]. Infant mortality is regarded as highly sensitive indicators of population and child health [5]. In LMIC, a large number of births take place outside of health facilities, usually at home and unattended by formally trained doctors or midwives [6]. Preceding studies indicated that IM was hindered by epidemics of HIV/AIDS, malaria, war and conflicts in most of the nation [7].

Infant mortality is associated with community, socio-economic, maternal, infant factor, proximate and delivery factors that are the burdens of public health [8]. Past studies indicate that IM was caused by prematurity factors, congenital causes, injury, other infections, infant infections, maternal conditions, Sudden Infant Death Syndrome, lack of oxygen to the fetus and infant during delivery [9]. Maternal age was found to the factor of IM used as a proxy for physiological, maternal psychological maturity and experience in child-care. Young mothers below 20 years normally tend to have biological, emotional, social and economic problems that frustrate their entire childbearing process. Maternal age affects the survival of a child during the first year of life [10]. Young mothers are less experienced at childcare because they are socially and economically disadvantaged [11-13]. Health knowledge features prominently in the literature as a potential mechanism by which education is associated with higher use of health services [14]. IM was assumed to occur due to birth complications, congenital anomalies, physiological problems and gestational immaturity. Injuries and other factors related to environment, nutrition and infectious diseases account for post-neonatal mortality. Diseases including gastroenteritis and pneumonia are common causes of IM in underdeveloped nations [15]. In developed countries, these deaths are less likely to occur, given the ability to control infectious diseases and to monitor nutritional needs. There is the possibility of accidents, assaults or homicides as the cause of infant deaths [16]. The infant deaths was attributed to SIDS constituting of smoking, lack of breastfeeding and lack of safe sleeping environment [17,18].

Past studies indicated that the relationship between short afterbirth intervals and high infant and child mortality was established. Very

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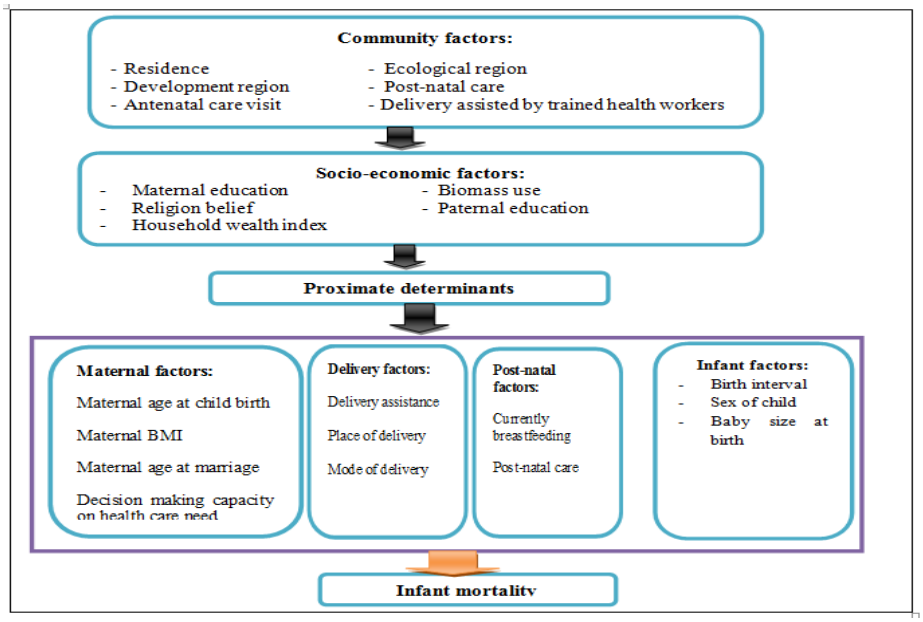

Figure 1: Model analysis of the study.

long intervals (at least 5 years in length) and shorter birth interval are the predictors of IM [19]. They also showed that IM was associated with the post-neonatal where the variations in mortality by maternal age were larger. Marital status is an important proxy measure of factors traditionally related to post-neonatal mortality, such as socio-economic influence and other circumstances not reflected by education [11]. IM happens in different stage such as very-natal mortality, neonatal mortality, early post-neonatal mortality, late post-neonatal mortality and the last stage is the infant mortality where the death happens before celebrating the first birthday [20].

Infant Mortality Rate (IMR) was 85% prior to the Genocide against the Tutsis, and increased dramatically in the aftermath of the tragic events of 1994, reaching a peak of 10.7% in 2000. Since that time it has fallen dramatically to 8.5% by 2005, 6.2% in 2008, and 5% in 2010. To achieve the Millennium Development Goal target of 2.8% reduction [21]. IM in Rwanda has fallen gradually from 12.3% in 1966 to 3.11% in 2015. Community Health Workers (CHWs) contribute to reduction of the financial, infrastructural, and geographical barriers to accessing health care by providing effective and efficient basic health care services at the community level to pregnant women. In 2012, IMR was 48.6% and was higher among boys (53%) than girls (44%). However, IMR has decreased a lot and more quickly during the last decade: from 139% in 2002 to 48.6‰ in 2012. IMR fell gradually from 123% in 1966 to 31.1% in 2015 [22]. Rwanda has made substantial progress nationwide in decreasing the infant mortality rate. This study aims at building the model of infant mortality and its associated risks factors in Rwanda from 2011-2015.

Methods and Materials

Study design

Cross-sectional survey was conducted on Rwandans using 2014/2015 Rwanda Demographic and Health Survey. Target population was women aged 15-49 years from sampled households. All 492 of the clusters selected were surveyed for 2014/2015 RDHS. Among these households, 30,058 completed the Household Questionnaire including 6,069 (20%) from urban and 23,989 (80%) resided in rural. The composite sample analysis, which accounted for the sampling weight due to multistage stratified sampling, was used in the surveys to gain accurate estimations of standard errors and confidence intervals.

Statistical analysis

Analytical analyses were performed using STATA version 13. The logistic regression model was performed because of its appropriateness in analyzing the effect of several risk factors on a dichotomy variable and significant level used was 5% and 95% confidence interval. Coefficient of determination was used for evaluating the effectiveness of a regression model. The multiple logistic regression method and regression equation were computed. Chi-square test was computed to compare the associated risk factors and demonstrate the association between the factors and infant mortality.

As the present study was based on secondary analysis of existing RDHS data, the investigators of this study did not seek approval from an Institutional Review Board. RDHS consisted of data that are standardized and they may be used by anyone in the empirical studies. Explanatory factors were grouped into 3 categories based on the model including socio-economic, community and proximate determinants (Figure 1).

Results

Infant mortality for women who gave birth to one child in five years was 34.5% died and 50.3% was for women who gave birth to 2 children in 5 years before the survey. These results indicated that the likelihood of IM increased as a woman had more children. The infants born to mothers living with partners, widowed, divorced and no-longer had 1.67, 1.87, 3.32, 2.44 and 2.48 times higher to die than the infants born to married mothers respectively. The significant

association between educational background and IM was computed (x^2=76.37; p=0.000). The infant born to mothers who studied primary, secondary and university school were 0.6, 0.3 and 0.21 less likely to be died than infants born to illiterate mothers. The birth interval was significantly associated with IM (x^2=0.7412; p=0.000). There was no significant correlation between the IM and marital status (x^2=9.87; p=0.079). The residence was significantly associated with IM (x^2=76.3; p=0.000). The findings showed that the rural children faced higher mortality rates than their urban counterparts at 85.3% while the Eastern province had high IM with 31.73% (x^2=138.84; p=0.000). Parental education was significantly associated with IM (x^2=202.13; p=0.000). Gender was associated with IM where males occupied 53.67% with (x^2=15.26; p=0.000).

Dummy variables displayed that when an infant was born to the illiterate mother, it decreased the chance of living because their mothers had insufficient experience and maturity to provide parental care to the infants. The model analysis shows that maternal education, residence, maternal age at first birth, and birth interval increased the probability of an infant dying. The negative coefficients on variables, including place of residence, province, husband's occupation, husband's age and the maternal marital status indicated that this probability reduced the likelihood of an infant living. The positive coefficient on such factors including maternal education, paternal education, sex of child, age at first birth and birth interval indicated that the probability of survival increased as the number of infants' death was low.

IM = 3 + 0.224 maternal education + 0.049 maternal age + 0.83 birth interval – 0.095 marital status – 0.144 residence – 0.084 husband education + 0.006 husband age + 0.133 breastfeed + 0.156 toilets – 0.035 age at first birth

Infants born in rural areas were 1.54 (0.95-1.69) times at risk of dying under a year compared to those born in urban areas. Children born to mothers aged 14-19 and 20-29 had OR [1.229(0.62-2.42) and 1.23(0.78-1.33)] respectively, mothers within these age groups have a higher likelihood of their infant dying compared to other age groups. The women aged 30-34 had [OR=0.69(0.54-0.89)], 35-39 was [OR=0.43(0.4-0.46)], 40-44 was [OR=0.06(0.057-0.062)] and 45-49 [OR=0.22(0.21-0.23)]. IM was higher in males [OR=1.15(1.07-1.23)] and the children who were not breastfed in the first year of life were 1.89 times more at risk to die compared to infants who were breastfed.

Findings indicated that the risk of dying for children born to mothers who completed secondary school was 0.3 less compared to children born to illiterate mothers; the risk of dying for children born to mothers who received higher education were 0.21 less likely to die compared to children born to illiterate women. These results showed that the probability of IM decreases with maternal education. The results indicated that the odd ratio of IM was 0.56 for children who were considered a large size at birth and 0.52 for infants of average size. These children were less likely to die compared to children who were very large at birth. The results also indicated that children who had a small birth size were 1.12 times more likely to die compared to children with a very large birth size. Children who were very small at the time of birth were 2.67 times more likely to die compared to children who were born very large whereas the risk of infants with an unknown size dying was 8 times higher than the children who were considered a very large size at birth.

Antenatal Care (ANC) was an important indicator to determine IM. The results showed that pregnant women who completed two visits to a health facility were 0.93 less likely to experience IM than who attended one visit in ANC period. The women who completed three visits were 0.81 times less likely to experience IM compared to pregnant women with only one visit at health facility. In terms of maternal occupations, infants born to mothers whose occupation were household, services, skilled and unskilled were 0.74, 0.47, and 0.88 less likely to die compared to women with skilled professions.

Discussion

The results confirmed that the risk of dying for children who were not breastfed was 1.89 times more likely compared to children who were breastfed. Children born to the mothers who did not receive prenatal healthcare had 1.2 more risk of experiencing IM than infants whose mothers attended prenatal care services. Women who did not receive prenatal healthcare services by the nurse had 1.3 times higher risk of experiencing IM than women who attended the prenatal services. Children born to mothers who received prenatal healthcare by CHWs were 0.02 less likely to die compared to infants born to women who did not receive health-care from CHWs. These findings were similar to the findings of prior studies [23].

The children born to married mothers below the age of 18 had a higher risk of dying compared to children whose mothers were married at age 18 or older [24]. The results revealed that infants born to young mothers ages 10-24 were more likely to die during the study compared to older mothers. But other research showed that women younger than 18 ages and over the age of 35 at their first birth had IMR. Younger women lack the necessary knowledge to care for their child; older women who give birth risk the death of an infant because their body may not be able to handle pregnancy. The age at first birth influenced more the life of infants [2]. The results confirmed a significant association between short afterbirth intervals and high infant mortality (x^2=0.74; p=0.000). These results were relevant with the previous studies that confirmed that very long intervals and very short birth interval were highly associated with IM [6,10].

The infants were more likely to die in the post-neonatal period versus the neonatal period. IM was higher in single women, who had the highest rate of IM at 4.1%. These results were similar to previous studies [23]. The maternal education played the fundamental role in decreasing IM. These findings were supported by preceding studies that confirmed that mothers with less education were more likely to lack childcare knowledge [11]. This was supported by findings from the previous studied that indicated that IM was high in rural areas due to numerous factors including lack of health facilities for hospitals, illiteracy, poverty, poor nutrition, and serious diseases [25,26].

Results indicated that children born to mothers with primary education are 0.64 less likely to die compared to those born to illiterate mothers; the risk of dying for children born to mothers with secondary education was 0.42 times lower than that of the illiterate mothers, while the risk of dying for children born to the mothers with university studies was 0.08 times lower than that of illiterate mothers. These results were significant and consistent with earlier studies [26]. Preceding that indicated that child survival was not influenced

by education at all ages but the results revealed that the education was significantly associated with IM at antenatal, prenatal and post-neonatal stages. These staged were mostly associated with IM in the neonatal period, which was more affected by biological processes of the newborn. Mothers who received follow-up care at health facilities in prenatal and post-natal periods were not at high risk of having IM compared to women who were not followed-up [23].

Children born to mothers aged 20-24 were 0.08 less likely to die compared to children born to mothers aged 10-19 years old, while the risk of dying for children born to mothers who were aged 30-34 was 0.1 less compared to the children born to mothers aged 20-24 years. This revealed that the children whose mothers were very young were at high risk of death, while the risk of dying for children born to mothers who were older than 25 were at low risk of death. These results were similar from the previous studies conducted Sub-Saharan Africa countries [25,27,28].

Conclusion

Infant mortality was associated with community, ecological, socio-economic and proximate factors. The advocacy and awareness campaigns on females' education should be emphasized to ensure that future mothers are equipped with skills and competences necessary to meet child health care needs. All health institutions are recommended to reinforce maternal and child health focusing on the complex factors of infant mortality.

Availability of Data and Material

Data supporting the results reported in the manuscript are found at National Institution of Statistics of Rwanda that funded 2014/2015 Rwanda Demographic and Health Survey. Dataset used are available from the corresponding author.

Author's Contributions

Emmanuel Biracyaza designed the study and wrote the manuscript. He performed the statistical analysis and acts as guarantor for the current paper. Samuel Habimana critically revised the manuscript and contributed to the discussions. All authors contributed to data analyses, results interpretation and draft the manuscript for publication. They all read and approved the final manuscript.

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