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The risk factors of infant mortality in Somalia: evidence from the 2018/2019 Somali health & demographic survey

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Abstract

Background Globally, infant mortality is one of the major public health threats, especially in low-income countries. The infant mortality rate of Somalia stands at 73 deaths per 1000 live births, which is one of the highest infant death rates in the region as well as in the world. Therefore, the aim of this study was to ascertain the risk factors of infant mortality in Somalia using national representative data.

Method In this study, data from the Somali Health and Demographic Survey (SHDS), conducted for the first time in Somalia in 2018/2019 and released in 2020, were utilized. The analysis of the data involved employing the Chi-square test as a bivariate analysis. Furthermore, a multivariate Cox proportional hazard model was applied to accommodate potential confounders that act as risk factors for infant death.

Results The study found that infant mortality was highest among male babies, multiple births, and those babies who live in rural areas, respectively, as compared to their counterparts. Those mothers who delivered babies with small birth size and belonged to a poor wealth index experienced higher infant mortality than those mothers who delivered babies with average size and belonged to a middle or rich wealth index. Survival analysis indicated that mothers who did use ANC services (HR = 0.740; 95% CI = 0.618–0.832), sex of the baby (HR = 0.661; 95% CI = 0.484–0.965), duration of pregnancy (HR = 0.770; 95% CI = 0.469–0.944), multiple births (HR = 1.369; 1.142–1.910) and place of residence (HR = 1.650; 95% CI = 1.451–2.150) were found to be statistically significantly related to infant death.

Conclusion The study investigated the risk factors associated with infant mortality by analyzing data from the first Somali Health and Demographic Survey (SHDS), which included a representative sample of the country's population. Place of residence, gestational duration, infant's gender, antenatal care visits, and multiple births were identified as determinants of infant mortality. Given that infant mortality poses a significant public health concern, particularly in crisis-affected countries like Somalia, intervention programs should prioritize the provision of antenatal care services, particularly for first-time mothers. Moreover, these programs should place greater emphasis on educating women about the importance of receiving antenatal care and family planning services, in order to enhance their awareness of these vital health services and their positive impact on infant survival rates.

Keywords Infant mortality, ANC, Cox proportional hazard model, Somalia

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Introduction

The infant death rate is a crucial indicator of a nation's health. It reflects the socioeconomic welfare of mothers and infants, as well as the effectiveness of a country's health systems. According to [1], significant progress in reducing infant mortality over the last three decades. In 2019, an estimated 7.4 million children, adolescents, and youth died from primarily preventable causes. Of these deaths, 5.2 million occurred in children under the age of five. Within this age group, 2.4 million deaths occurred in the first four weeks of life, 1.5 million between the ages of 1–11 months, and 1.3 million between the ages of one to four years.

According to a study of 56 countries, infant mortality is a worldwide public health concern, accounting for 144 deaths per 1000 live births [2]. Between 1990 and 2017, the infant mortality rate in Sub-Saharan Africa decreased from 182 to 58 deaths per 1000 live births [3]. In the same vein, there were significant declines in the infant mortality rate recorded in Somalia between 2000 and 2016. The infant mortality rate reduced from 132 deaths per 1000 live births in 2000 to 80.4 and 73 deaths per 1000 live births in 2016 [4] and in 2022 [5], respectively. This makes Somalia one of the highest infant death rates in the region as well as in the world. In other words, an estimated 7 out of 100 children die before their 1st birthday. When compared to neighboring countries, such as Ethiopia and Kenya, with respective IMRs of 42 and 30.51 deaths per 1000 live births [3, 6], the current infant death rate in Somali is still unacceptable, and the progress made so far in this regard seems inadequate. These are staggering statistics that highlight the urgent need for action to improve mother and child health outcomes in Somalia. The high infant mortality rate of the country has been exacerbated by armed conflicts, recurrent droughts due to climate change, and increased global food prices. Therefore, research on infant mortality can help enhance both child and mother health by providing tangible recommendations.

Several studies have been undertaken around the globe to investigate risk factors that influence infant death. Lack of antenatal care follow-up, income status, birth interval, maternal age, maternal education [7, 8], domestic violence [9], health-related behavior such as postponing seeking health care [10], extreme poverty and living in rural areas [11], and having metabolic disorders [12] were identified as risk factors for infant mortality.

Despite the fact that infant mortality in Somalia is extremely high, there is no single study in the available literature on the risk factors related to infant death that employs nationally representative data. Therefore, the purpose of this study was to examine the risk factors of infant death in Somalia in order to ascertain problems that need to be addressed to maintain the decrease in infant death and improve child survival. Consequently, this will help the country in achieving SDGs. One of the specific SDGs targets is to reduce the U5MR to 25 per 1000 live births within 2030 [13]. However, with only six (6) years until the deadline, Somalia's prospects of achieving this goal appear uncertain. The rate of decline has been sluggish, dropping from 170.5 deaths in 2006 [4] to 117 deaths per 1,000 live births in 2021 [14]. Without reducing infant mortality in nations with higher rates, particularly in developing nations, where the majority of infant mortality occurs, this target cannot be met.

Data source and methods

The Somali Health and Demographic Survey (SHDS) was conducted in 2018/2019. This cross-sectional survey that was administered at the household level. The present study utilized data from the SHDS. At a country level, the survey gathers information on various demographic indicators such as fertility, mortality (child and infant), fertility preferences and regulations, health status of mother and child, nutritional health status of mother and child, and awareness and attitude toward HIV/AIDS.

Each of the eighteen pre-war geographical regions in Somalia was stratified into urban, rural, and nomadic areas, with the exception of the Banadir region which was considered completely urban. This resulted in a total of 55 sampling strata. For security reasons, all three strata of the Lower Shabelle and Middle Juba regions as well as the rural and nomadic strata of the Bay region were excluded, resulting in a final sampling frame of 47 strata. Using high resolution satellite imagery, a total of 10,525 EAs were digitized of which 7,488 and 3,037 were urban and rural areas, respectively. However, due to security, only 9,136 EAs were considered as the final sampling frame. For nomadic strata, SHDS used a sampling frame of 2,521 TNA (temporary nomadic settlement). In urban and rural strata, the SHDS followed a three-stage stratified cluster sample design with a probability proportional to size for the sampling of Primary Sampling Units (PSU) and Secondary Sampling Units (SSU) in the first and second stages, respectively, and systematic household sampling in the third stage. In the first stage, a total of 1,433 primary sampling units were chosen from 47 strata, with 770 primary sampling units from urban areas, 488 primary sampling units from rural areas, and 175 primary sampling units from nomadic areas, accounting for approximately 16% of the total frame of all primary sampling units. In the second stage, a total of 220 primary sampling units and 150 primary sampling units were assigned to urban and rural strata, respectively, and the same 175 primary sampling units were assigned to nomadic areas yielding a total of 545 primary sampling units. In the third stage for urban and rural and second stage for nomadic areas, a fixed number of 30 households

per cluster (Enumeration Areas) were selected to provide key demographic and health indicators with statistically reliable estimates for the country. The survey included approximately 15,870 households in the total sample, of which 15,761 were occupied. Of the occupied households, 15,761 were successfully selected for the survey. The SHDS interviewed 16,715 women, including 11,884 ever-married women and 4,831 never-married women.

Study variables

In this study, the covariates were classified as outcome and explanatory variables. The outcome variable was infant mortality, which was measured as the probability of a child dying before his/her first birthday. It was estimated based on information collected from the birth history section of the ever-married women questionnaire. Table 1 depicts the list of the included explanatory variables (i.e., risk factors for infant mortality) along with their definitions and categories. SHDS initially classified the wealth index for the households into five categories using what we call principal component analysis but for simplicity, we reduced them into three categories (poor, medium, and rich).

Statistical Data Analysis

Bivariate and multivariate analyses were conducted to assess the relationship between infant mortality and its associated factors. Bivariate analysis was performed to estimate the distribution of infant death in different groups of covariates. The survival of infants during the first year of life was examined using multivariate analysis, specifically the Cox proportional hazard model. This analysis aimed to investigate the impact of various factors, including the mother, child, and socioeconomic factors. The Cox proportional hazard model was employed for this study due to its suitability in analyzing time-specific censored observations.

The Cox proportional hazard model can be defined as follows:

$$h_i\left(t,\boldsymbol{x}\right)=h_0\left(t\right)e^{\beta_1 X_{i1}+\beta_2 X_{i2}+\ldots\ +\beta_k X_{ik}}$$

where $h_i\left(t,x\right)$ is the hazard function for an individual i which is a function of t and $\boldsymbol{x}$, $\boldsymbol{x}=\left(x_{i1}+x_{i2}+\ldots\ \ x_{ik}\right)$ are the vectors of covariates, $h_0\left(t\right)$ is the baseline hazard function when all covariance values are zero. This refers to the instantaneous hazard rate given to a case by default if there are no impacts of covariates. β_k denotes the coefficients of covariates

Results

Table 2 shows the risk factors of infant mortality in Somalia based on background characteristics. The risk factors were categorized into household, maternal and child-related covariates. The results show that women who live in rural areas have a significantly higher infant mortality rate compared to those living in urban areas. Additionally, there were higher rates of infant death reported among children whose mothers belonged to the poor wealth index compared to those whose mothers belonged to the medium or rich wealth index.

For mother-related risk factors, the rate of infant death was significantly higher among mothers who were under 18 years old at the time of their first birth and did not receive any antenatal care (ANC), compared to mothers who were at least 18 years old and received at least one ANC. Likewise, lower rates of infant death were observed among educated women, mothers who were employed, and those who gave birth at medical facility, in comparison to their counterparts.

In terms of child-related risk factors, infant death was more common in male babies, those with low birth weight, and those born prematurely, compared to their counterparts. Additionally, it was found that babies with a birth order of three (3) or higher had a higher

Table 1 Description of the covariates included in the analysis

Variable	Description and categorization
Settlement type	Type of settlement(0 = urban, 1 = rural)
Mothers educational status	Mothers educational status(0 = No, 1 = Yes)
Age at 1st birth	Age at 1st birth (0 = < 18 years 1 = ≥ 18 years)
Mothers occupation	Mothers occupation(0 = housewife, 1 = occupied)
Wealth Index	Wealth Index(0 = poor, medium = 1, 2 = rich)
No of ANC visits	Number of ANC visits(0 = No, 1 = at least one)
Sex of the child	Sex of the child at birth (0 = male; 1 = female)
Twins	Whether more than one child was born (0 = single; 1 = multiple).
Duration of pregnancy	Duration of pregnancy(0 = pre-term, 1 = term)
Place of delivery	Place of delivery(0 = home; 1 = medical facility)
Size of the child	child-size after birth(0 = small; 1 = average or larger)
Birth order	Birth order of the baby (0 = 0–2, 1 = ≥ 3)
No. TT injections	Number of tetanus toxoid injections (0 = 0–1 injections; 1 = ≥ 2 injections)

Table 2 Distribution of infant mortality by selected background characteristics in Somalia, 2018/2019 SHDS (*N* = 7178)

Background Characteristics	*N*	%	*P*-value
Household Characteristics			
Residence			
Urban	4000	4.5	0.030
Rural	3178	5.7	
Wealth Index			
Poor	1480	5.4	0.041
Medium	2976	4.1	
Rich	2731	3.5	
Maternal & child characteristics			
Age at 1st birth			
< 18	2240	4.8	0.008
≥ 18	4932	3.4	
Mothers educational status			
No	5909	4.9	0.024
Yes	1209	3.5	
Mothers occupation			
No	6684	3.4	0.014
Yes	492	4.7	
No of ANC visit			
No	4485	4.6	0.026
At least one	2693	3.9	
Sex of the child			
Male	3758	5.7	0.000
Female	3420	4.8	
No. TT injections			
0–1	5553	3.9	0.403
2^{+}	1625	3.5	
Place of Delivery			
Home	5295	4.2	0.139
Medical facility	1868	3.6	
Duration of pregnancy			
Pre-term	113	4.8	0.000
Term	7061	3.4	
Twins			
Single	7117	4.7	0.000
Multiple	61	5.8	
Child Size			
Small	1148	5.4	0.002
Average or larger	6030	3.5	
Birth order			
< 3	1898	3.1	0.016
≥ 3	5280	4.5	

Note: Samples are not equal due to missing cases and don't know

Table 3 Result of Cox proportional hazard model for infant mortality by selected background characteristics in Somalia, 2018/2019

Background Characteristics	Hazard Ratio (HR)	*P*-value	95% CI
Household Characteristics			
Residence			
Urban*	1		
Rural	1.650	0.020	(1.451–2.150)
Wealth Index			
Poor*	1		
Medium	0.817	0.128	(0.540–1.236)
Rich	0.789	0.64	(0.581–1.071)
Maternal & child characteristics			
Age at 1st birth			
< 18*	1		
≥ 18	0.520	0.167	(0.467–1.489)
Mothers educational status			
No*	1		
Yes	0.991	0.961	(0.698–1.408)
Mothers occupation			
No*	1		
Yes	0.837	0.476	(0.514–1.364)
No of ANC visit			
No*	1		
At least one	0.740	< 0.001	(0.618–0.832)
Sex of the child			
Male*	1		
Female	0.661	0.017	(0.484–0.965)
No. TT injections			
0–1*	1		
2^{+}	0.093	0.562	(0.802–1.501)
Place of Delivery			
Home*	1		
Medical facility	0.929	0.621	(0.692–1.245)
Duration of pregnancy			
Pre-term*	1		
Term	0.770	0.018	(0.469–0.944)
Twins			
Single*	1		
Multiple	1.369	0.008	(1.142–1.910)
Child Size			
Small*	1		
Average or larger	0.841	0.792	(0.775–1.397)
Birth order			
< 3*	1		
≥ 3	1.201	0.218	(0.711–1.261)

Note: $*$ = Reference Category

probability of death, compared to newborns with a birth order of less than three (3). Furthermore, the probability of infant death was higher among multiple births, compared to singleton births.

According to the Cox proportional hazard model output presented in Table 3, the sex of the child, duration of pregnancy, place of residence, multiple births and ANC were found to be statistically significantly related to infant death. The risk of infant death was found to be lower among mothers who made at least 1 ANC visit compared to their counterparts (HR = 0.740; 95% CI = 0.618–0.832). This indicates that mothers who received at least 1 ANC visit had a 26% reduced likelihood of experiencing

infant mortality, in comparison to mothers who did not receive any ANC visits. The risk of mortality in female children was approximately 34% lower than in males (HR=0.661; 95% CI=0.484–0.965). Multiple births were associated with a 1.369 times higher likelihood of infant mortality compared to singleton births (HR=1.369; 95% CI=1.142–1.910). Preterm infants had a 23% increased risk of mortality compared to full-term infants (HR=0.770; 95% CI=0.469–0.944). Similarly, the probability of infant death was 1.65 times higher among households living in rural areas compared to those in urban areas (HR=1.650, 95% CI=1.451–2.150).

Discussion

In this study, we found that place of residence, child sex, duration of pregnancy, birth order, multiple births and antenatal care (ANC) visits were statistically significantly related to the response variable (infant death). The infant death rate of 73 per 1000 live births in Somalia was in line with the infant death rate of the African region, which is 73 per 1000 live births. However, the infant death rate in Somalia was significantly higher than that of other African countries except for Sierra Leone (80.10 per 1000 live births) and the Central African Republic (77.50 per 1000 live births), ranking third in the world. The major contributing factors to this variance may be the disparities in socioeconomic status, access to healthcare services, and other infrastructures.

The risk of infant death was higher among male babies compared to female babies. This finding is consistent with studies conducted in Kenya [15], Nigeria [16] and Pakistan [17]. However, another study conducted in Brazil revealed no relationship between child sex and infant mortality [7]. The risk of infant mortality is greater among male infants than female infants, possibly due to biological and genetic differences between the two sexes, with males being genetically weaker and more prone to illness and early death [18].

The risk of mortality among infants born two or more was higher than singletons. This finding is in line with other studies conducted in Kenya [15], Greece [18, 19], Brazil [7, 20], Nigeria [21], Ethiopia [22] and Jordan [23]. Multiple births can make it difficult for the mother to care for the babies, putting them at risk for malnutrition and infections. Moreover, when there are several pregnancies, the chance of low birth weight increases, which has an impact on the survival of the child.

The probability of death was higher among infants born prematurely compared to full term infants. This finding is corroborated by other studies [7, 24]. This could be attributable to respiratory morbidity, feeding issues, hyperbilirubinemia, unstable temperature, infection, and hypoglycemia, which are more prevalent in premature infants than term infants [25, 26]. The risk of death was higher among infants whose mothers did not attend antenatal care (ANC) services compared to the infants whose mothers attend ANC services. This result is supported by the studies of [27, 28] which found that mothers who experienced fewer infant deaths have undergone the best possible medical treatment, including antenatal and postnatal care. This is further evidenced by the study conducted by [17], who concluded that over three-fourths of infant deaths were avoidable.

The probability of infant mortality was lower in urban households compared to rural households. This finding aligns with similar studies conducted in America and Pakistan [11, 29].

Maternal education, a significant infant mortality in multiple studies [7, 8], was not statistically linked to infant death in this study. The reasonable explanation could be the difference in quality of the education offered across various nations. In addition, more than two decades of armed conflict have nearly ruined Somalia's educational system, which is marked by poor quality, a lack of competent teachers, and insufficient resources. Moreover, the variation in sample sizes may potentially be a factor in the discrepancy.

Conclusion and policy implications

The study investigated the risk factors of infant mortality based on the 1st Somali Health Demographic Survey(SHDS) data, a nationally representative data set. Duration of pregnancy, sex of the child, antenatal visits and multiple births were statistically associated with infant death. Since infant death is a major public health problem, intervention programmes should focus on providing antenatal care services for pregnant women, especially those who are becoming mothers for the first time. Pregnant women can benefit from antenatal care by learning about good pregnancy practices from trained medical personnel, recognizing the warning signs of pregnancy and childbirth, and receiving social, emotional, and psychological support during this critical time in their life. Furthermore, pregnant mothers can get tetanus vaccinations, therapy for hypertension to avert eclampsia, vitamin supplements, and other vital services through antenatal care. In regions where malaria is widespread, medical professionals can provide pregnant mothers with treatments and mosquito nets to support prevention of this occasionally fatal illness.

These infant deaths can be prevented with access to well-trained midwives, nurses and other health professionals during antenatal visits. These cost-effective interventions should be available to Somali mothers and babies who need them most. Intervention programmes should also give more focus to mothers with multiple births, babies born prematurely and mothers with higher-order child birth.

Abbreviations

SHDS	Somali Health and Demographic Survey
ANC	Antenatal Care
HR	Hazard Ratio
IMR	Infant Mortality Rate
CI	Confidence Interval
TT	Tetanus Toxoid

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Author contributions
All authors contributed to the preparation of the manuscript. Dahir Abdi Ali performed introduction writing of the manuscript, methodology, data collection, analysis, first draft preparation and organization of the manuscript. Nasra Abdulhalim Mohamed & Abdirahman Ibrahim Ismail re-analyzed the data using Cox proportional hazard model. Gallad Dahir Hassan reviewed and edited the first draft. All authors read and approved the final manuscript.

Data availability
The data set used and/or analyzed during the current study is available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The permission to use the SHDS data was obtained from Somali National Bureau of Statistics and the data is anonymized.

Consent for publication
N/A.

Competing of interest
The authors declare that they have no competing interests.

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