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Research article

A predictive model and socioeconomic and demographic determinants of under-five mortality in Sierra Leone

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ABSTRACT

Sierra Leone is among the countries that recorded high under-five child mortality rate in the world. To design and implement policies that can address this public health challenge, the present study developed a predictive model of factors that explained under-five mortality in Sierra Leone using the 2008 and 2013 Sierra Leone Demographic and Health Survey (SDHS) datasets. LASSO regression technique was used to select the predictors to build the under-five predictive single-level logit and multilevel logit models. Statistical analyses were performed in the R freeware version 3.6.1. About 588 (10.4%) and 1320 (11.1%) children under five were reported dead in 2008 and 2013, respectively. The significant predictors of under-five mortality in Sierra Leone were the total number of children ever born, number of children under five in the household, mother's birth in the last five years, mother's number of living children, and number of household members, household wealth, maternal contraceptive use and intention, number of eligible women in the household, type of toilet facility, sex of the child, and weight of the child at birth. The study identified certain predictors that deserve policy attention and interventions to strengthen the efforts of creating child welfare and survival atmosphere in Sierra Leone.

1. Introduction

Even though the world has recorded a significant decline in under-five mortality in the past three decades, the progress has been uneven in Sub-Saharan Africa (SSA) and South Asia (You et al., 2015). Majority of the countries in SSA and Southern Asia were unable to meet the Millennium Development Goal (MDG) 4 and may not meet the newly set Sustainable Development Goal (SDG) 3 by 2030 (Mejía-Guevara et al., 2019; You et al., 2015). The SDG target 3.2 seeks to reduce under-five mortality to about 25 per 1000 live births in all countries by 2030 (UNICEF, 2018). In 2017, however, the average under-five mortality rate in low- and middle-income countries (LMICs) was 69 deaths per 1000 live births while the same in high-income countries was 5 deaths per 1000 live births (WHO, 2018). In that same year, SSA accounted for almost half of the 5.4 million under-five deaths in the world (WHO, 2018).

With the current estimated 111 deaths per 1000 live births, Sierra Leone is one of the first five countries with regrettably high under-five mortality rates (Mejía-Guevara et al., 2019). Like many countries in SSA, non-governmental organizations, developmental partners, and the Government of Sierra Leone have pursued and undertaken policies and initiatives that seek to reduce child mortality (Bertone et al., 2014). However, some scholars made gloomy forecasts of child survival in Sierra Leone by indicating that the under-five mortality rate will slightly increase to 115 deaths per 1000 live births by 2030 if the country's slow pace of mortality reduction remains unchanged as that estimated from 2000 to 2015 (Mejía-Guevara et al., 2019). Poverty, limited access to safe drinking water and adequate sanitation, poor feeding and hygienic practices, overcrowded housing, and limited access to quality health services are the main underlying factors of the following conditions and diseases responsible for child deaths in Sierra Leone: malnutrition, diarrhoeal diseases, malaria, tuberculosis and HIV/AIDS (WHO. Regional

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Office for Africa, 2016). With the current under-five mortality trend and inadequate cutting-edge research-informed policies, it has been suggested that the rate may be higher than projected, putting Sierra Leone among the countries most likely to miss the SDG 3.2.

The economic development and growth of many countries are partly attributable to their commitment to encouraging and promoting high volumes of rigorous scientific research on multiple quality of life outcomes (Solarin and Yen, 2016). Many of the developed countries have extremely low rates of under-five mortality, suggesting that policymakers and other development actors of these countries doggedly pursued and invested in scientific research-driven policies and programs that effectively addressed the political, socio-economic, and environmental factors that were important in explaining variabilities in child mortality outcomes (Pechholdová, 2015).

Due to the generally low research output in Sierra Leone (Guerrero, 2014; Jackson, 2015), the rarity of nationally representative empirical research on under-five mortality presents an opportunity to fill this gap (Liwin and Houle, 2019). The present study addressed this gap by employing the least absolute shrinkage and selection operator (LASSO) regression technique and single-level and multilevel logistic regressions to analyse the nationally representative demographic and health survey datasets with the primary objective to develop a predictive model of under-five mortality in Sierra Leone. The LASSO regression technique identified multiple relevant factors that were not considered in a similar study published elsewhere (Liwin and Houle, 2019), highlighting the strength of the analytical approach of the present study.

2. Materials and methods

2.1. Design

The 2008 and 2013 datasets used in this study were from the Sierra Leone Demographic and Health Survey (SDHS). The SDHS employed a population-based cross-sectional research design (Statistics Sierra Leone (SSL) & ICF International, 2014; Statistics Sierra Leone (SSL) & ICF Macro, 2009).

2.2. Data collection and source

Detailed information on the data collection, sampling techniques, and procedures adopted in the SDHS are described elsewhere (Statistics Sierra Leone (SSL) & ICF International, 2014; Statistics Sierra Leone (SSL) & ICF Macro, 2009). Mothers of children under-five were interviewed by administering questionnaires that solicited socioeconomic, demographic, and health information (Statistics Sierra Leone (SSL) & ICF International, 2014; Statistics Sierra Leone (SSL) & ICF Macro, 2009). Data were collected on 5,631 and 11938 dyads of mothers aged 15–49 years and their young children 0–5 years in 2008 and 2014, respectively.

2.3. Analytic sample

Summary statistics of the potential study variables were performed for all cases, and missing cases on any of the study variables were duly recorded. Cases with complete information on the selected variables in the datasets were used for the LASSO, single-level, and multilevel logistic regression analyses. There were complete records on 5,237 and 11,476 dyads of mothers and their young children in the 2008 and 2014 datasets, respectively.

2.4. Measures

Response variable: The response variable in this study was under-five mortality status categorized as a child is dead (coded as 1) or alive (coded as 0).

Predictor Variables: Forty-one variables were initially selected from the datasets, but ten with high proportions of missing cases were removed from the datasets [S-Table 1].

2.5. Statistical analyses

Statistical analyses were performed using the following packages in the R freeware version 3.6.1 (R Core Team, 2019): pastec, car, sjstats, caret, glmnet, lme4, randomForest, and pROC. The statistical significance thresholds for all analyses of the association between the response and the predictor variables were pegged at $p \leq 0.01$ and $p \leq 0.05$.

Summary statistics: sample characteristics were expressed as frequencies and percentages and medians.

Least Absolute Shrinkage and Selection Operator (LASSO) regression: This is a machine learning technique, whose algorithm was used to select the most appropriate risk factors from a list of variables to build models of under-five mortality in Sierra Leone. The LASSO algorithm causes regression coefficients for some variables to shrink toward zero (Hastie et al., 2005). Variables with non-zero regression coefficients variables are most strongly associated with the response variable; thus, they were used to build the model (Hastie et al., 2005).

Single-level and multilevel logistic regression: Single-level logistic regression was performed with the selected variables from the LASSO regression analyses [S-Table 2, 3]. Taking the primary sampling unit as a community of residence, a random intercept (multilevel) logistic regression technique was performed to ascertain whether the under-five child mortality outcome varies from one community of residence to another. The goodness of fit for the multilevel models was tested using the variance partitioning coefficient (VPC), Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). McFadden Pseudo R^2 (values from 0.2-0.4 indicate excellent model fit) was also used to further test the fit of the preferred model. Assumptions of multicollinearity were checked, and no violations were observed [S-Table 4].

2.6. Ethical considerations

The 2008 and 2013 SDHS protocol was reviewed and approved by the Sierra Leone Ethics and Scientific Review Committee and the Institutional Review Board of ICF International. Informed consent was also obtained from participants before they were interviewed. The SDHS is publicly available upon a simple, registration-access request, so no further ethical clearance was sought.

3. Results

3.1. Sample characteristics

About 10.4% (588 out of the 5,631) and 11.1% (1320 out of 11938) of children under five were reported dead in 2008 and 2013, respectively. A little over half of the sample were males in both 2008 (50.4%) and 2013 (50.1%). Most children were delivered at home [70.6% in 2008; 43.3% in 2013]. Majority of the children belonged to mothers who were currently married/living together with a partner [88% in 2008 and 86.4% in 2013]. Most children belonged to mothers who had no formal education [73.4% in 2008 and 68.3% in 2013]. Many of the children resided in rural areas [65.9% in 2008 and 69.4%]. Many of the children were in the northern part of the country [32.9% in 2008 and 39.2% in 2013]. The remaining sample characteristics are reported in [S-Table 5].

3.2. A predictive model of under-five mortality from the 2008 Sierra Leone DHS dataset

Results from the LASSO logistic regression analyses revealed that the following nine variables are important features for building a predictive model of an under-five mortality from the 2008 SDHS dataset: a mother's history of ever terminating a pregnancy, contraceptive use and intention

to use, total number of children ever born, number of children 5 and under in the household, number of eligible women in the household, births in the last five years, number of living children, household wealth, and number of household members. The predictors in the model explained about 33% of the variability in the response variable [McFadden R^2: 0.325]. The single-level logit model was extended to a multilevel (mixed effect) logistic regression model to explore any unobserved community-level effects on the under-five mortality, but no significant unobserved community-level variations were observed in under-five mortality outcome. Thus, the results in the single-level logit model were interpreted.

The predictive model revealed that the total number of children ever born, the number of children under five in the household, mother's birth in the last five years, mother's number of living children, household wealth, and the number of household members made a statistically significant contribution to the model.

A unit increase in the total number of children ever born and the number of births in the last 5 years were associated with increased odds of a child dying before age five. An increase in the number of children under-five in the household and an increase in the number of a mother's living children is associated with decreased odds of a child dying before age five. Compared to children who were born in the poorest households, children who were born in poorer households were less likely to die before age five. An increase in the number of household members is associated with increased odds of a child dying before age five. The McFadden R^2 of 0.325 suggests an excellent fit for the model (Table 1).

3.3. A predictive model of under-five mortality from the 2013 Sierra Leone DHS dataset

Results from the LASSO logistic regression analyses revealed that the following sixteen variables from the 2013 SDHS dataset are important risk factors explaining the variance in under-five mortality: place of delivery, contraceptive use and intention to use, marital status, maternal education, total number of children ever born, number of children 5 and under in the household, number of eligible women in household, births in last five years, number of living children, type of toilet facility used by household, source of drinking water by household, watching the television (TV), number of household members, child sex, weight of child at birth, and maternal age. The predictors in the single-level logit model explained about 31% of the variability in the response variable [McFadden R^2: 0.309], suggesting an excellent fit for the model. The single-level logit model was extended to a multilevel (mixed effect) logistic regression model to explore any unobserved community-level effects on the under-five mortality, but no significant unobserved community-level variations were observed in under-five mortality outcome. Thus, the results in the single-level logit model were preferred and interpreted.

The predictive model revealed that mother's contraceptive use and intention to use, maternal education, the total number of children ever born, number of children under five in household, mother's birth in the last five years, mother's number of living children, type of toilet facility, number of household members, sex of the child, and weight of the child at birth made statistically significant contribution to the model.

Table 1. The 2008 predictive model of under-five mortality in Sierra Leone.

	Single Level Logit Model	Multilevel Logit Model
	aOR [95% CI]	aOR [95% CI]
Intercept	0.07*** [0.04, 0.12]	0.07*** [0.04, 0.12]
Mother ever terminated pregnancy		
No	1.00 (reference)	1.00 (reference)
Yes	1.36 [0.98, 1.88]	1.37 [0.99, 1.89]
Contraceptive Use and Intention		
Using modern method	1.00 (reference)	1.00 (reference)
Using traditional method	1.94 [0.83, 4.31]	1.94 [0.85, 4.42]
Non-user intend to use later	0.86 [0.58, 1.30]	0.86 [0.58, 1.29]
Does not intend to	0.86 [0.58, 1.29]	0.86 [0.58, 1.28]
Total number of children ever born	2.33*** [2.13, 2.58]	2.34*** [2.13, 2.57]
Number of children 5 and under	0.32*** [0.28, 0.37]	0.32*** [0.28, 0.37]
Number of eligible women in House	1.02 [0.87, 1.19]	1.02 [0.87, 1.19]
Births in last five years	3.40*** [2.84, 4.08]	3.40*** [2.84, 4.08]
Number of living children	0.25*** [0.22, 0.29]	0.25*** [0.22, 0.29]
Household wealth		
Poorest	1.00 (reference)	1.00 (reference)
Poorer	0.65* [0.45, 0.94]	0.65* [0.45, 0.94]
Middle	0.90 [0.64, 1.25]	0.90 [0.64, 1.26]
Richer	0.84 [0.59, 1.19]	0.84 [0.59, 1.19]
Richest	0.98 [0.69, 1.39]	0.98 [0.69, 1.39]
Number of household members	1.14*** [1.09, 1.20]	1.14*** [1.09, 1.20]
McFadden R^2	0.325	
Random Effects		
Observations	5237	5237
Second-level units		351
VPC		0.00%
AIC	2296.9	2298.9
BIC	2395.345	2403.9
Deviance	2266.9	2266.9

aOR: Adjusted odds ratio, CI: Confidence interval.
*: p-value < 0.05. **: p-value < 0.01. ***: p-value < 0.001. n=5,237.

Table 2. The 2013 predictive model of under-five mortality in Sierra Leone.

	Single Level Logit Model	Multilevel Logit Model
	OR [95% CI)	OR [95% CI)
(Intercept)	0.06 [0.04, 0.10]	0.06 [0.038, 0.10]
Place of delivery		
Home	1.00 (reference)	1.00 (reference)
public hospital	1.10 [0.87, 1.38]	1.10 [0.87, 1.39]
public health centre	0.91 [0.76, 1.07]	0.91 [0.76, 1.07]
Public health post or other	0.86 [0.61, 1.19]	0.86 [0.62, 1.20]
private hospital/clinic/other	0.70 [0.38, 1.24]	0.70 [0.39, 1.27]
Contraceptive use and intention		
Modern method	1.00 (reference)	1.00 (reference)
Using traditional method	0.91 [0.35, 2.11]	0.91 [0.37, 2.23]
Non-user - intends to use later	0.78* [0.64, 0.95]	0.78* [0.64, 0.95]
Does not intend to use	0.85 [0.69, 1.06]	0.85 [0.69, 1.06]
Marital Status		
Never married	1.00 (reference)	1.00 (reference)
Currently married/living with partner	0.87 [0.66 1.14]	0.87 [0.66, 1.14]
Ever married/widowed/divorced/separated	1.21 [0.82, 1.80]	1.21 [0.82, 1.80]
Maternal education		
No education	1.00 (reference)	1.00 (reference)
Primary	1.01 [0.82, 1.25]	1.01 [0.82, 1.25]
Secondary	0.81 [0.65, 1.02]	0.81 [0.65, 1.02]
Higher	0.33* [0.11, 0.81]	0.33* [0.12, 0.89]
Total number of children ever born	2.07*** [1.94, 2.21]	2.07*** [1.94, 2.21]
Number of children 5 and under	0.38*** [0.34, 0.41]	0.38*** [0.34, 0.41]
Number of eligible women in HH	1.15** [1.05, 1.27]	1.15** [1.05, 1.27]
Births in last five years	3.62*** [3.20, 4.10]	3.62*** [3.19, 4.10]
Number of living children	0.28*** [0.26, 0.31]	0.28*** [0.26, 0.31]
Type of toilet facility		
Open defecation (bush/beach/field]	1.00 (reference)	1.00 (reference)
Flush type of toilet facilities	0.92 [0.55, 1.49]	0.92 [0.56 1.51]
Ventilated Improved Pit Latrine	1.31* [1.03, 1.65]	1.31* [1.03, 1.65]
Pit latrine with slab	1.00 [0.80, 1.26]	1.00 [0.80, 1.26]
Pit latrine without slab	1.21 [0.99, 1.49]	1.21 [0.99, 1.48]
others (composting/bucket toilet/hanging toilet)	1.64 [0.97, 2.68]	1.64 [0.99, 2.71]
Source of drinking water		
River/stream	1.00 (reference)	1.00 (reference)
Piped water into dwelling/yard	0.82 [0.48, 1.36]	0.82 [0.49, 1.38]
Public tap/standing pipe	0.91 [0.69, 1.18]	0.91 [0.69, 1.18]
Tube well/borehole	0.93 [0.74, 1.18]	0.93 [0.74, 1.18]
Protected well	0.86 [0.69, 1.09]	0.86 [0.69, 1.09]
Unprotected well	0.95 [0.71, 1.27]	0.95 [0.71, 1.27]
Spring (protected/unprotected)	0.97 [0.76, 1.23]	0.97 [0.76, 1.24]
Bottled/sachet water	0.67 [0.25, 1.60]	0.67 [0.27, 1.69]
others (rain, tunker, etc)	1.89 [0.87, 3.78]	1.89 [0.91, 3.93]
Watching the TV		
Not at all	1.00 (reference)	1.00 (reference)
Less than once a week	0.93 [0.65, 1.31]	0.93 [0.65, 1.32]
At least once a week	0.82 [0.61, 1.09]	0.82 [0.61, 1.10]
Number of household members	1.14*** [1.10, 1.18]	1.14*** [1.10, 1.18]
Sex of child		
Male	1.00 (reference)	1.00 (reference)
Female	0.83* [0.72, 0.96]	0.83* [0.72, 0.96]
Weight of the child at birth		
Very large	1.00 (reference)	1.00 (reference)
Larger than average	0.98 [0.77, 1.26]	0.98 [0.77, 1.25]
Average	1.06 [0.85, 1.34]	1.06 [0.85, 1.33]
Smaller than average	1.63*** [1.25, 2.13]	1.63*** [1.25, 2.13]
Very small	1.82*** [1.31, 2.52]	1.82*** [1.31, 2.52]

(*continued on next page*)

Table 2 (*continued*)

	Single Level Logit Model	Multilevel Logit Model
	OR [95% CI)	OR [95% CI)
Don't know (can't tell)	2.54*** [1.67, 3.85]	2.54*** [1.67, 3.86]
Maternal Age		
15–19 years	1.00 (reference)	1.00 (reference)
20–24 years	0.81 [0.62, 1.07]	0.81 [0.62, 1.07]
25–29 years	0.88 [0.66, 1.17]	0.88 [0.66, 1.17]
30–34 years	1.02 [0.73, 1.41]	1.02 [0.73, 1.41]
35–39 years	1.21 [0.84, 1.74]	1.21 [0.84, 1.74]
40–44 years	1.21 [0.75, 1.94]	1.21 [0.75, 1.95]
45–49 years	1.35 [0.74, 2.41]	1.35 [0.75, 2.43]
McFadden R^2	0.309	
Random Effects		
Observations	11,476	11,476
Second-level units		435
VPC		0.00%
AIC	5502.3	5504.3
BIC	5840.28	5849.6
Deviance	5410.3	5410.3

aOR Adjusted odds ratio, CI Confidence interval.
*: p-value < 0.05. **: p-value < 0.01. ***: p-value < 0.001. n=11,476.

Children of mothers who were non-users of contraceptive but intends to use later were less likely to die before age five. Children from mothers with higher education (postsecondary) have decreased odds of dying before age five compared to children from mothers with no education. A unit increase in the total number of children a mother ever born, mother's births in the last five years, and an increase in the number of reproductive-age women in the household were associated with increased odds of a child dying before age five. The number of children under five and an increase in a mother's number of living children were associated with decreased odds of dying before age five. Children of households that used ventilated improved pit latrines were more likely to die before age five compared to children whose households have no toilet facility. An increase in the number of household members is associated with increased odds of a child dying before age five. Female children had decreased odds of dying before age five compared to male children. Compared to children whose weights were very large at birth, children with smaller than average, very small, and unknown birth weights were associated with increased odds of dying before age five (Table 2).

3.4. Area under the receiver operating characteristic (ROC) curve (AUROC)

Figure 1 presents the results for the AUROC. It shows an area under the ROC curve of 89.2% and 88.4% for the preferred models of the 2008 and 2013 survey rounds, indicating a good predictive ability of the fitted models to predict under-five mortality.

4. Discussion

The aim of the study was to build a predictive model and examine factors that account for under-five mortality in Sierra Leone using the LASSO regression and multivariate logistic regression techniques. The study further investigated whether the under-five mortality outcome varies from one community to another by using a random intercept logistic regression technique, but no statistically significant unobserved community-level variations were observed in the under-five mortality outcome.

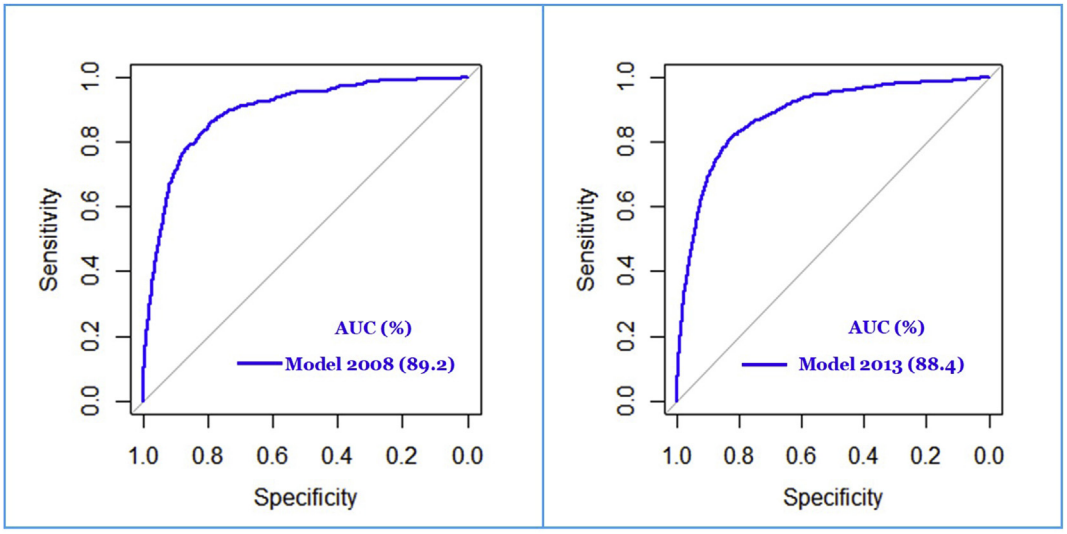

Figure 1. Area Under Receiver Operating Characteristic curve of multiple logistic models for predicting under-five mortality outcome.

The increase in the total number of children ever born and in a mother's births in the last five years were associated with increased odds of under-five mortality. The cross-sectional nature of the datasets makes it impossible to establish direct causality of these risk factors of under-five mortality. There is a possibility that mothers who have lost any child may seek a replacement by giving birth to another, and this could explain the association between these risk factors and under-five mortality (Abir et al., 2015; Mugo et al., 2018). The results of the present study corroborate the results of other studies conducted in sub-Saharan Africa and in other LMICs (Gyimah et al., 2012; Nasejje et al., 2015). In addition, both variables are directly related to family planning so encouraging and supporting women to adopt and use appropriate family planning methods to increase birth spacing could help mitigate against complications for the mother which could help improve survival among these group of children (Aheto, 2019; Amoroso et al., 2018; Boerma and Bicego, 1992; Rafalimanana and Westoff, 2001).

An increase in the number of children under-five in the household and an increase in the number of a mother's living children decreases the likelihood of a child's death before age five. Mothers of living children may have acquired knowledge and experience over time from raising children, and this could explain the protective effect of this variable on child survival. A number of explanations can be offered for the protective effect of an increase in the number of under-five children in a household on child survival. There could be multiple mothers with living under-five children in the household, making it possible for these mothers to learn and share experiences and encourage each other to engage in best practices of raising and caring for infants and children. If there is only one mother in a household, an earlier explanation for the protective effect of an increase in the number of a mother's living children is applicable here. These results confirm (Aheto, 2019) and contradict (Kanmiki et al., 2014) the findings of other studies in Ghana.

An increase in the number of household members and in the number of reproductive-age women in the household were associated with a child's death before age five. A possible explanation for these results could be that more household membership could create constraint resource situations, making it difficult for under-five children to be adequately fed and nurtured. A study in Ethiopia also found that an increase in the number of household members increases the likelihood of under-five mortality (Ayele et al., 2015).

The present study found that compared to children of mothers who were using a modern form of contraceptive, children of mothers who were non-users of contraceptive but intends to use later were less likely to die before age five. Generally, there is a low prevalence of modern contraceptive use among reproductive-age women in Sierra Leone (UNFPA, 2017), making the use of modern contraceptive of no effect on under-five mortality. Another possible explanation is that mothers who were currently non-users but intends to use contraceptives later might have gotten their ideal number of surviving children and might be making plans for childbirth control, and this could explain why their children were less likely to die.

Compared to poorest households, children who were born in poorer households were more likely to die before age five. Contrary to expectation, being born in a richer or the richest households did not have any significant impact on child survival in Sierra Leone. Probably, the wealth gap between the poorest households and poorer households might be very significant, giving a survival advantage to children who were born in poorer households. Contrary to the results here, many studies found that dwelling in richer households increases children's survival beyond age five (Ezeh et al., 2015; Lartey et al., 2016; Sahu et al., 2015).

Contrary to expectation, compared with children who resided in households that practices open defecation, children who resided in households whose main toilet facility was ventilated improved pit latrine were more likely to die before age five. In the sanitation literature, a ventilated improved pit latrine that is not hygienically maintained becomes a medium of spreading infections and diseases such as diarrhoea (Adane et al., 2017), which is the second leading cause of child mortality in the world (Liu et al., 2016). Studies have documented similar findings, accentuating the debilitating consequence of improper sanitation on child survival, health, growth and development (Ezeh et al., 2014).

Male children and children with smaller than average and small birth weights were more likely to have died before age five. Regarding the sex of the child, numerous studies in sub-Saharan Africa have established that female children were more likely to survive their first five years compared to their male counterparts (Aheto, 2019; Ezeh et al., 2015; Van Malderen et al., 2019). In most African cultures, male children are circumcised within the first two weeks of life. Failure to properly treat the wound around the male child's genital could predispose him to severe infections, leading to death (Weiss et al., 2010). Regarding birthweight, studies also found that low birthweight is a significant risk factor of under-five mortality (Akinyemi et al., 2015; Iliodromiti et al., 2017; Watkins et al., 2016).

5. Conclusions

This study investigated the predictive factors of under-five mortality in Sierra Leone between 2008 and 2013. The predictive abilities of the fitted logistic regression models of under-five mortality in 2008 and 2014 were good with the area under the ROC curve values of 89.2% and 88.4%, respectively. The LASSO logistic regression identified the following nine variables as important features for building a predictive model of an under-five mortality in 2008: a mother's history of ever terminating a pregnancy, contraceptive use and intention to use, total number of children ever born, number of children 5 and under in the household, number of eligible women in the household, births in the last five years, number of living children, household wealth, and number of household members. The same technique identified the same nine variables, except the household wealth, in addition to the following as important predictors for building a predictive model of an under-five mortality in 2013: current marital status, highest educational level, type of toilet facility, source of drinking water, frequency of watching television, sex of child, size of the child at birth, and maternal age. The following variables made statistically significant contributions to both the 2008 and 2013 models: the total number of children ever born, the number of children under five in the household, mother's birth in the last five years, mother's number of living children, and the number of household members. For the recent 2013 DHS dataset, these additional variables made statistically significant contributions to the fitted model: mother's contraceptive use and intention to use, maternal education, type of toilet facility, sex of the child, and weight of the child at birth. Although household wealth was statistically significantly associated with under-five mortality in 2008, its effect disappeared in 2013. To strengthen the efforts of creating child welfare and survival atmosphere in Sierra Leone, policies, programs and interventions should seek to economically empower households and assist them to have access to hygienic toilet facilities, create and promote opportunities that encouraged women to have access to formal education, and empower women to access and use contraceptives.

Data availability statement

The data that support the findings of this study were obtained from the DHS MEASURE Program which is freely available after a simple, registration-access request (Statistics Sierra Leone (SSL) & ICF International, 2014; Statistics Sierra Leone (SSL) & ICF Macro, 2009).

Declarations

Author contribution statement

T.E. Tagoe, E.K. Nakua, P.A. Duodu and J.J. Nutor: Conceived and designed the experiments; Wrote the paper.

P. Agbadi and J.M.K. Aheto: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

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