Factors associated with co-current under-five morbidity and sibling mortality in Liberia: A cross-sectional study

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ABSTRACT

INTRODUCTION Liberia's under-five mortality rate remains high, with an estimated 12000 deaths annually. This study examined the intra-generational and recurrent child health risks, including whether mortality risks persist among surviving siblings.

METHODS The study used secondary retrospective data generated by administering questionnaires to guardians in the 2019–2020 Liberia Demographic and Health Survey for 5132 living de jure household members aged under five years nested within 3893 households. This cross-sectional study analyzed epidemiological factors at the child, maternal, household, and environmental levels associated with under-five comorbidity (intermediate outcome) and sibling mortality (distal outcome).

RESULTS The results revealed recurrent and intra-generational vulnerabilities within households. Approximately 7.4% of the children had experienced the death of at least one sibling, with nearly half of the 7.4% simultaneously affected by co-morbidities. Multivariable analysis identified 16 significant shared and outcome-specific determinants ($p<0.05$) of under-five outcomes. Open birth intervals and maternal autonomy in health decision-making were linked to higher odds of co-morbidity but lower odds of sibling mortality. Protective factors for both outcomes included religion (Muslim), mosquito-net use, and residence in North Central Liberia, while contact with hunted wildlife increased the odds of co-morbidity and sibling mortality. Additional factors were uniquely associated with morbidity and with sibling mortality.

CONCLUSIONS The results reveal persistent, interconnected under-five and sibling health risks clustered at the household level in Liberia, calling for further longitudinal studies to clarify these relationships.

INTRODUCTION

Under-five Mortality Rate (U5MR) measures the likelihood that a child will die before reaching five years of age per 1000 live births[1]. In 2023, the leading global causes of under-five deaths were mainly preventable, including preterm birth complications (739671; 18%), lower respiratory infections (610000; 14%), neonatal asphyxia and trauma (603606; 12%), malaria (424386; 9%), and diarrhea (340429; 9%)[1-3]. Despite a 52% decline in global under-five mortality between 2000 and 2023 – from 77 to 37 deaths per 1000 live births – child mortality remains high, with 4.8 million deaths in 2023 and 170 million over the past two decades[1,4]. Mortality risks vary widely, with low-income countries experiencing 62 deaths per 1000 live births versus 5 in high-income countries and 43 in low-middle-income countries[4].

Without accelerated action, an estimated 30 million under-five deaths could occur by 2030, nearly 60% in Sub-Saharan Africa[1,4]. In 2023, Sub-Saharan Africa accounted for 2.7 million (56%) of global under-five deaths, 14 times higher U5MR than Europe. In 2023, Sub-Saharan Africa had 46% of global neonatal deaths, and 20 countries exceeded 60 deaths per 1000 live births (United Nations Inter-Agency Group for Child Mortality Estimation, 2025; WHO, 2024a). Leading causes in the region were malaria (416861), neonatal asphyxia and trauma (334596), preterm birth complications (307793), lower respiratory infections (263872), and diarrhea (247439)[2]. SDG 3.2 calls for under-five mortality ≤25 and neonatal mortality ≤12 per 1000 live births by 2030[5], reinforcing the right to survival[6]. Accelerated progress could prevent 8 million under-five deaths, including

3.3 million neonates, by 2030[1].

Liberia has faced major challenges, including civil conflict (1989–2003) and Ebola outbreaks, which undermined governance, social services, and population health outcomes[7,8]. Despite this, Liberia has made progress in rebuilding institutions, strengthening health systems, expanding primary care, and improving immunization and maternal-child health services[9]. Liberia's National Reproductive, Maternal, Newborn, Child & Adolescent Health + Nutrition Policy promotes integrated health services and strengthened systems, including data-driven decision-making[10]. Supporting this, the Child Survival Action Plan (2024–2026) and Child Survival Strategy (2024–2028) target under-five mortality reduction to 52 deaths per 1000 live births by 2028[11,12]. Despite these efforts, Liberia records ~12000 under-five deaths annually, with leading causes in 2023 being malaria (2576), neonatal asphyxia and trauma (1450), diarrhea (952), preterm complications (773), and lower respiratory infections (569)[2].

The framework of Mosley and Chen[13] identifies multiple determinants affecting child health, particularly under-five mortality and sibling morbidity. Five key proximate determinants include maternal factors (age, parity, birth interval), environmental contamination (water and sanitation), nutritional deficiencies, injuries, and personal preventive and curative measures. Underlying determinants – individual, family, cultural, institutional, and environmental factors – indirectly shape outcomes through these proximate determinants[13]. This framework provides a comprehensive lens for understanding the complex interrelationships impacting child health[13]. For instance, regional disparities were significant determinants of under-five mortality in Nigeria, Gambia, Sudan, and Ethiopia[14–17], while environmental exposures such as carbon emissions and zoonotic disease risks were associated with increased child mortality in Nepal and other settings[18,19]. Additionally, low socio-economic status, inadequate antenatal and postnatal care, maternal age, early breastfeeding practices, male sex, multiple births, and short birth intervals were consistently linked to higher under-five mortality in Ghana and Ethiopia[14,20].

Beyond mortality itself, under-five deaths have important implications for surviving siblings. Studies in sub-Saharan Africa show that post-neonatal mortality during infancy negatively affected survivors' height-for-age and school attendance[21], while bereavement responses were intensified among children who lost multiple siblings up to the age of 25 years[22]. Additionally, co-occurring infections such as pneumonia and diarrhea in Ethiopia highlight how morbidity clusters within households[23]. Collectively, these findings underscore that under-five mortality and morbidity are influenced by interconnected biological, environmental, and social determinants that extend their effects to surviving children[21,22].

UNICEF emphasizes the importance of ongoing surveillance of child morbidity and mortality in regions with persistently high under-five deaths[1]. Identifying under-five shared risk factors can guide integrated interventions in resource-limited settings to mitigate morbidity and mortality simultaneously[13]. However, limited evidence exists on how under-five mortality affects surviving siblings' health, challenging governments and humanitarian organizations in designing effective interventions[10].

The current study, therefore, aimed to examine intra-generational and recurrent child health risks by identifying determinants of under-five mortality and assessing whether these risks persist among surviving siblings.

METHODS

Study design, setting, and population

This is a secondary dataset analysis of the cross-sectional 2019–2020 Liberia Demographic and Health Survey (LDHS). Liberia is a Sub-Saharan African country located in West Africa[24]. The LDHS is a nationally representative survey that employed a stratified two-stage cluster sampling design derived from the 2008 Population and Housing Census[25]. In the first stage of sampling, Enumeration Areas (EAs), also referred to as villages or clusters, were randomly selected, followed by the selection of households in the second stage. The LBKR recode file includes information on children aged 0–59 months, both living and deceased, at the time of the survey. These data were collected from respondents who provided detailed information on the children[26]. A comprehensive description of the sampling methodology is provided in the LDHS report[26].

Sample size

The 2019–2020 Liberia Demographic and Health Survey children's dataset initially included 5704 under-five children (459 deceased, 113 *non–de jure*, and 5132 living) nested within 3893 households. Household and child identifiers were linked to determine survival status, and a household-level variable indicating whether a child had ever lost a sibling was created. Deceased cases were excluded due to missing epidemiological data, and *non–de jure* children were excluded because they were not usual household residents, leaving 5132 living under-five children for analysis.

Measurement and variables

Outcome variables

The study examined two outcome variables: under-five comorbidity (intermediate outcome) and sibling mortality (distal outcome). Under-five comorbidity was measured among children under five years using three caregiver-reported indicators – diarrhea, cough, and fever in the two weeks preceding the survey. Children who experienced two or three infections were classified as having comorbid conditions, while those with one or no infection were classified as not having comorbid conditions. Sibling mortality was measured using a derived household-level

variable indicating whether a child had experienced the death of a sibling.

Independent variables

The study included covariates related to the child, mother, household, and environment. Child-related variables included sex, birth order, birth weight, type of gestation, preceding birth interval, and succeeding birth interval. Maternal variables included age, age at first birth, education level, marital status, religion, employment status, and health insurance coverage. Household variables included place of delivery, whether any household member became ill during the Ebola Virus Disease epidemic, decision-making authority regarding the mother's health, and household wealth status. Environmental and contextual variables included type of residence, region, cooking fuel, source of drinking water, stool disposal facility, household smoking exposure, and whether the respondent had ever touched hunted wild animals. The categorization of variables is published elsewhere[27].

Data analysis and management

The dataset was weighted, and survey settings were applied to account for the complex sampling design. Descriptive statistics summarized children's characteristics, while chi-squared tests assessed differences in proportions by morbidity and survival status. Multivariable logistic regression models identified factors associated with under-five comorbidity and sibling mortality. Several of the above-stated covariates, particularly child age and sex, maternal age and education level, household member coming into contact with hunted wild animals, and household wealth, were considered potential confounding factors[27] and were adjusted for in the multivariable analyses. The variable on household contact with hunted wild animals was retained in the models due to its contextual relevance[27], and all independent variables were assessed for multicollinearity before model estimation. Data were analyzed using Stata version 15[28]. Missing data were handled using imputation[29].

Ethical considerations

Ethical approval was not required because the study used publicly available secondary data. Access to the anonymized 2019–2020 Liberia Demographic and Health Survey (LDHS) dataset was formally requested and granted[30]. The LDHS followed the Declaration of Helsinki, obtained written informed consent from respondents, and received approval from the Institutional Review Board of ICF International[26].

RESULTS

Description of the study participants

About 7.4% of under-fives had lost at least one sibling, and 44.5% had experienced at least one infection. Malaria and ARI each affected about a quarter of the children (28.0% and 26.3%), while diarrhea affected 17.9%. Among children who had lost a sibling, 3.6% were experiencing comorbidities. Slightly over half were female (50.7%) and 23.3% were first born. Small but notable proportions faced early-life risks, including short preceding birth intervals (4.4%), short succeeding birth intervals (2.1%), low birth weight (6.0%), and twin births (2.7%). Regarding maternal characteristics, most mothers were aged 20–24 years (24.0%), Christian (84.3%), uninsured (97%), married (72.4%), and not formally employed (67.5%). About half were married between the ages of 18 and 29 years (54.1%), and 42.2% had no formal education.

Regarding household factors, 21.6% of children were delivered at home, and 45.9% did not sleep under a mosquito net the night before the survey. More than half lived in households with multiple under-fives (55.0%), and most mothers lacked autonomy in making decisions about their own health (59.8%). With regard to environmental factors, 66.3% of children lived in rural areas and 53.1% in households without stool disposal facilities. Most households relied on wood for cooking (70.7%) and lacked electricity (69.9%). Only 0.7% lived in households with a tobacco smoker, about one-third were from Southeastern Liberia (32.2%), and 46.1% had household members who had ever contacted hunted wild animals (Supplementary file Table 1).

Differentials in under-five co-morbidity and sibling loss by epidemiological, child, maternal, household, and environmental factors

Co-morbidity was defined as the presence of at least two of ARI, malaria, or diarrhea in an under-five. The Pearson chi-squared analysis showed significant associations ($p<0.05$) between both under-five co-morbidity and sibling mortality and factors such as preceding and succeeding birth intervals, maternal age, education level, religion, household number of under-fives, women's decision-making autonomy, and exposure to hunted wild animals. Higher proportions of concurrent co-morbidity and sibling mortality were observed among first-born children (19.4% co-morbidity; 4.9% sibling mortality), children with long preceding birth intervals (4.8%; 3.6%), children whose mothers were aged 20–24 years (5.5%; 2.3%), Christians (19.4%; 6.2%), children in households with other under-fives, in households where the wife's health decisions were made by someone else (8.7%; 3.1%), and in households where at least one member had ever been exposed to hunted wild animals (42.0%; 4.1%).

Bivariate analysis indicated that several factors were significantly associated with under-five morbidity ($p<0.05$) but not with sibling mortality ($p>0.05$), including the child having malaria, ARI, or diarrhea, birth weight, sleeping under a mosquito net the night before the survey, maternal marital status, region of residence, and availability of household stool disposal facilities. Co-infection affected 19% of children with malaria compared with 2% of those without malaria, 18% of children with ARI compared with 3% without ARI, and 12% of children with diarrhea compared with 10% without

diarrhea. Low birth weight children had 2% co-infection compared with 16% among those with normal birth weight. Children in households without a stool disposal facility had 11% co-infection, compared with 6% in households with pit latrines and 4% in those with flush toilets.

Several factors were significantly associated with under-five siblings' mortality ($p<0.05$) but not with morbidity ($p>0.05$), including birth order, gestation type, place of delivery, household wealth index, number of under-fives in the household, type of residence, cooking fuel, source of drinking water, and history of contact with hunted wild animals. Sibling mortality was highest among children of birth order 3–5 (3.4%), compared with 1.0% among first-born and 1.2% among second-born children, while those of birth order ≥6 had 2.0%. Mortality was 5.3% among hospital births, compared with 2.0% for home births. Children from the poorest households had the highest mortality (2.7%), compared with 0.5% among the richest. Rural children experienced higher mortality than urban children (5.8% vs 1.5%). Mortality was also higher in households using wood for cooking (5.7%) versus electricity/LPG (0.1%), and those relying on wells for drinking water (5.8%) versus tap water (0.1%) (Supplementary file Table 1).

Epidemiological, child, maternal, household, and environmental factors associated with under-five co-morbidity and sibling mortality

The multivariable logistic regression results identified 16 statistically significant determinants ($p<0.05$), including five factors shared by both outcomes, seven factors specific to under-five morbidity, and four factors specific to sibling mortality in Liberia, as presented in Tables 1–3. Considering factors common to both under-five outcomes (morbidity and sibling mortality), under-fives who had open birth intervals (last-born children) and those whose mothers had full autonomy to independently make health-related decisions exhibited a consistent pattern of association: both groups had significantly higher odds of co-morbidity (AOR=2.10;

Table 1. Child determinants of under-five co-morbidity and sibling mortality in a cross-sectional study using the 2019–2020 Liberia Demographic and Health Survey dataset (N=5132)

Variables	Co-morbidity		Sibling loss	
	AOR (95% CI)	p	AOR (95% CI)	p
Child has malaria	*			
No (ref.)			1.00	
Yes			1.049 (0.795-1.383)	0.737
Child has ARI	*			
No (ref.)			1.00	
Yes			1.231 (0.934–1.622)	0.140
Child has diarrhea	*			
No (ref.)			1.00	
Yes			1.126 (0.842–1.507)	0.424
Succeeding birth intervals				
Short (≤17 months) (ref.)	1.00		1.00	
Long (18–33 months)	0.841 (0.449–1.576)	0.590	0.87 (0.439–1.726)	0.691
Longer (≥34 months)	0.544 (0.273–1.085)	0.084	0.48 (0.224–1.028)	0.059
Under-fives in open birth intervals	2.101 (1.167–3.782)	**0.013**	0.388 (0.2–0.753)	**0.005**
Birth weight			*	
Large (ref.)	1.00			
Average	1.201 (1.004–1.438)	**0.045**		
Small	1.672 (1.23–2.274)	**0.001**		
Don't know	0.773 (0.254–2.352)	0.650		
Gestation type				
Single (ref.)	1.00		1.00	
Twins	0.758 (0.49–1.173)	0.213	5.066 (3.269–7.85)	**0.001**

*Variables not considered for multivariable analysis due to multi co-linearity. AOR: adjusted odds ratio; adjusted for child age and sex, maternal age and education level, household member coming into contact with hunted wild animals, and household wealth.

Table 2. Maternal determinants of under-five co-morbidity and sibling mortality in a cross-sectional study using the 2019–2020 Liberia Demographic and Health Survey dataset (N=5132)

Variables	AOR (95% CI)	p	AOR (95% CI)	p
Maternal age (years)				
15–19 (ref.)	1.00		1.00	
20–24	0.944 (0.724–1.23)	0.669	1.745 (1.091–2.792)	0.020
25–29	0.773 (0.582–1.026)	0.075	1.098 (0.661–1.824)	0.718
30–34	0.778 (0.576–1.051)	0.102	1.022 (0.599–1.742)	0.938
35–39	0.923 (0.681–1.251)	0.606	1.049 (0.612–1.798)	0.863
40–44	0.752 (0.525–1.078)	0.121	1.007 (0.542–1.869)	0.983
45–49	0.753 (0.453–1.252)	0.275	1.2 (0.532–2.705)	0.660
Maternal education level				
No education (ref.)	1.00		1.00	
Primary	1.322 (1.106–1.58)	**0.002**	0.93 (0.706–1.226)	0.608
Secondary	1.242 (1.008–1.53)	**0.042**	0.724 (0.511–1.025)	0.069
Post-secondary	1.43 (0.823–2.483)	0.204	0.488 (0.141–1.689)	0.258
Marital status				
Never in union (ref.)	1.00		1.00	
Married	1.022 (0.819–1.276)	0.845	0.978 (0.678–1.409)	0.904
Widowed	1.082 (0.528–2.221)	0.829	0.82 (0.267–2.521)	0.729
Separated	1.562 (1.158–2.108)	**0.004**	0.993 (0.594–1.66)	0.979
Religion				
Christian (ref.)	1.00		1.00	
Muslim	0.578 (0.44–0.76)	**0.001**	0.649 (0.423–0.997)	**0.048**
No religion and traditional	0.805 (0.493–1.314)	0.385	1.694 (0.957–3.001)	0.071
Place of delivery				
Home (ref.)	1.00		1.00	
Hospital	0.91 (0.76–1.089)	0.304	0.935 (0.71–1.231)	0.630
Wealth index				
Poorest (ref.)	1.00		1.00	
Poorer	1.04 (0.857–1.262)	0.691	1.29 (0.962–1.731)	0.089
Middle	1.067 (0.828–1.375)	0.614	1.104 (0.73–1.670)	0.639
Richer	1.446 (0.997–2.096)	0.052	1.032 (0.542–1.966)	0.923
Richest	1.585 (1.005–2.5)	**0.048**	1.249 (0.580–2.689)	0.570
Number of living under-fives in a household				
0 (ref.)	1.00		1.00	
1	0.448 (0.039–5.189)	0.521	0.137 (0.011–1.707)	0.122
2	0.547 (0.047–6.337)	0.629	0.088 (0.007–1.109)	0.060
3	0.458 (0.039–5.353)	0.534	0.052 (0.004–0.673)	**0.024**
≥4	0.443 (0.037–5.277)	0.519	0.129 (0.01–1.694)	0.119
Decision maker on the mother's own health				
Husband alone (ref.)	1.00		1.00	
Herself	1.399 (1.08–1.813)	**0.011**	0.491 (0.319–0.755)	**0.001**
Someone else	0.892 (0.722–1.103)	0.292	0.613 (0.455–0.824)	**0.001**

*AOR: adjusted odds ratio; adjusted for child age and sex, maternal age and education level, household member coming into contact with hunted wild animals, and household wealth.

95% CI: 1.17–3.78; p=0.013, and AOR=1.40; 95% CI: 1.11–1.81; p=0.011, respectively) but significantly lower odds of sibling mortality (AOR=0.39; 95% CI: 0.20–0.75; p=0.005, and AOR=0.49; 95% CI: 0.32–0.78; p=0.001, respectively), compared with under-fives in short succeeding birth intervals and those whose mothers lacked such autonomy.

Additionally, lower odds of co-current under-five co-morbidity and sibling mortality were observed among: 1) Muslim children (AOR=0.58; 95% CI: 0.44–0.76; p=0.001 for co-morbidity; AOR=0.65; 95% CI: 0.42–1.00; p=0.048 for sibling loss), compared with Christian under-fives; **2)** those living in households where some children slept under a mosquito net the night before the survey (AOR=0.68; 95% CI: 0.51–0.913; p=0.011 for co-morbidity; AOR=0.491; 95% CI: 0.319–0.775; p=0.001 for sibling loss), compared with households where all under-fives did not sleep under a mosquito net; and 3) those from North Central region (AOR=0.44; 95% CI: 0.34–0.57; p=0.001 for co-morbidity;

Table 3. Environmental determinants of under-five co-morbidity and sibling mortality in a cross-sectional study using the 2019–2020 Liberia Demographic and Health Survey dataset (N=5132)

Variables	AOR (95% CI)	p	AOR (95% CI)	p
Type of residence				
Urban (ref.)	1.00		1.00	
Rural	1.209 (0.991–1.475)	0.061	1.675 (1.191–2.356)	**0.003**
Region				
Northwestern (ref.)	1.00		1.00	
South Central	0.87 (0.673–1.125)	0.288	0.666 (0.448–0.989)	**0.044**
Southeastern A	0.824 (0.627–1.082)	0.163	0.67 (0.439–1.024)	0.064
Southeastern B	0.767 (0.584–1.008)	0.057	0.524 (0.337–0.813)	**0.004**
North Central	0.44 (0.34–0.571)	**0.001**	0.584 (0.397–0.859)	**0.006**
Type of energy used for cooking				
Wood (ref.)	1.00		1.00	
Electricity/LPG	0.857 (0.335–2.19)	0.747	2.288 (0.737–7.103)	0.152
Kerosene/charcoal	0.931 (0.717–1.209)	0.592	1.184 (0.775–1.81)	0.434
Source of water for drinking				
Tap (ref.)	1.00		1.00	
Well	1.821 (1.111–2.986)	**0.017**	1.426 (0.593–3.428)	0.428
Dam/river	1.915 (1.12–3.277)	**0.018**	1.591 (0.629–4.028)	0.327
Rainwater/tank	0.803 (0.161–3.998)	0.789	1.119 (0.115–10.885)	0.923
Mineral water	1.236 (0.688–2.221)	0.478	0.924 (0.301–2.834)	0.890
Stool disposal				
No facility (ref.)	1.00		1.00	
Pit latrine	1.25 (1.043–1.498)	**0.016**	0.909 (0.671–1.23)	0.535
Flush toilet	1.043 (0.82–1.327)	0.731	1.259 (0.86–1.842)	0.236
Ever touched wild hunted animal(s)				
No (ref.)	1.00		1.00	
Yes	1.429 (1.231–1.659)	**0.001**	1.506 (1.184–1.916)	**0.001**
Did not answer	1.154 (0.709–1.879)	0.564	1.158 (0.531–2.525)	0.713
All under-fives slept under mosquito nets				
No (ref.)	1.00		1.00	
Some	0.683 (0.51–0.913)	**0.010**	0.491 (0.319–0.755)	**0.001**
All	1.023 (0.88–1.189)	0.769	0.613 (0.455–0.824)	**0.001**

AOR: adjusted odds ratio; adjusted for child age and sex, maternal age and education level, household member coming into contact with hunted wild animals, and household wealth.

AOR=0.58; 95% CI: 0.397–0.859; p= 0.006 for sibling loss), compared with Northwestern region. Higher odds of co-current under-five co-morbidity and sibling mortality were observed among under-fives from households where at least one family member ever came into contact with hunted wild animals (AOR=1.43; 95% CI: 1.23–1.66; p=0.001 for co-morbidity; AOR=1.51; 95% CI: 1.18–1.92; p=0.001 for sibling loss), compared with those who did not.

Beyond the aforementioned five covariates shared by both study outcomes, under-five morbidity was uniquely associated with seven additional factors. Compared with children who were large at birth, those with average birth weight (AOR=1.20; 95% CI: 1.00–1.44; p=0.045) and small birth weight (AOR=1.67; 95% CI: 1.23–2.27; p=0.001) had higher odds of morbidity. Children born to mothers with primary (AOR=1.32; 95% CI: 1.11–1.58; p=0.002) and secondary education (AOR=1.24; 95% CI: 1.01–1.53; p=0.042) were more likely to experience morbidity compared with those whose mothers had no formal education. Higher odds of morbidity were also observed among children of separated mothers (AOR=1.56; 95% CI: 1.16–2.11; p=0.004) relative to single mothers. In addition, under-fives from households in the richest wealth quintile had increased odds of morbidity compared with those from the poorest households (AOR=1.59; 95% CI: 1.01–2.50; p=0.048). Children from households using wells (AOR=1.82; 95% CI: 1.11–2.99; p=0.017) or dams/rivers (AOR=1.92; 95% CI: 1.12–4.00; p=0.018) as sources of drinking water were more likely to experience morbidity than those using tap water. Finally, stool disposal in pit latrines was associated with higher odds of morbidity compared with households without stool disposal facilities (AOR=1.25; 95% CI: 1.04–1.50; p=0.016).

Beyond the above-mentioned five covariates shared by both study outcomes, under-five sibling mortality was uniquely associated with four additional factors. Compared with singletons, twins had substantially higher odds of under-five mortality (AOR=5.07; 95% CI: 3.27–7.85; p=0.001). Higher odds of mortality were also observed among children born to mothers aged 20–24 years (AOR=1.75; 95% CI: 1.09–2.79; p=0.020) compared with those born to mothers aged 15–19 years, and among children residing in rural areas (AOR=1.67; 95% CI: 1.19–2.36; p=0.003) compared with their urban counterparts. In contrast, lower odds of under-five mortality were observed among children living in households with three living under-fives (AOR=0.05; 95% CI: 0.004–0.67; p=0.024) relative to households with no other living under-fives.

DISCUSSION

The study results demonstrate a substantial burden of under-five morbidity and sibling mortality in Liberia, providing evidence of recurrent and intra-generational vulnerability within households. Childhood exposure to sibling loss often coincided with high morbidity, as nearly half experienced multiple infections such as malaria, ARIs, and diarrhea. This reflects the clustering of child illness and mortality within households due to shared biological, environmental, and socio-economic conditions[22], and supports the concept of mortality 'scarring', where surviving siblings remain exposed to the same risks[21]. The persistence of risk within affected households underscores the need for further studies that track children and households over time to better understand the household-level mechanisms linking sibling mortality and child morbidity.

Open succeeding birth intervals were associated with higher under-five co-morbidity, but lower sibling mortality compared with short intervals, highlighting the complex role of birth spacing. Short intervals (<24 months) increase mortality risk due to maternal depletion and resource competition, while longer intervals improve survival without fully protecting against common illnesses[31]. Further longitudinal studies are needed to better understand the relationship between birth spacing, child morbidity, and mortality outcomes.

The finding that Muslim under-five children had lower odds of both concurrent morbidity and sibling mortality compared with Christian under-fives aligns with evidence from an Irish study. In Ireland, Catholics and Church of Ireland members experienced the highest child mortality rates, while Presbyterians had the lowest[32]. These results suggest that religious affiliation may act as a proxy for underlying social, behavioral, and community-level factors rather than exerting a direct causal effect. Future research should investigate how religion interacts with socio-economic conditions, health behaviors, and access to healthcare to influence child health outcomes.

In the current study, children whose mothers had full autonomy in health-related decision-making had higher odds of co-morbidity but lower odds of sibling mortality. The study results are consistent with the results of earlier studies, which indicated maternal autonomy's dual and context-dependent effects. Earlier studies indicated that mothers' decision-making autonomy enhanced detection and reporting of illness (leading to higher comorbidity metrics) while simultaneously enhancing actions that prevent progression to fatal outcomes[33]. The study results reflect complex and multifaceted effects of maternal empowerment on child health, and underscore the importance of interpreting morbidity and mortality together.

The current study established lower odds of co-occurring under-five morbidity and sibling mortality in households where some children slept under a mosquito net. This is in consonance with earlier studies that indicated that increased Insecticide Treated Mosquito Nets (ITN) utilization is linked to broader survival benefits among children[34]. ITN utilization reflects the well-established use and protective effects of ITNs against malaria and related health risks[35,36]. These findings highlight the need for additional research using designs that allow stronger causal inference.

Additionally, lower odds of co-current under-five co-morbidity and sibling mortality were observed among under-fives from the North Central region compared with the Northwestern region. Related results have been reported elsewhere. In Nigeria, a study revealed that regional factors were among the strongest determinants, contributing to neonatal, infant, and under-five mortality[14]. Similar regional disparities were reported in Sudan[16] and The Gambia[15]. Although the present study did not isolate the specific drivers of regional variation in Liberia, these results highlight the need for further investigation to clarify the regional and socio-economic factors affecting under-five morbidity and sibling mortality, especially in the Northwestern region.

Higher odds of co-current under-five co-morbidity and sibling mortality were observed among under-fives from household where at least one family member ever came into contact with hunted wild animals compared with those who did not. A review of zoonotic disease etiology shows that the majority of the human pathogens – including bacteria, viruses, fungi, protozoa, and parasites – originate from animals[18]. Hunted wildlife species can present elevated spillover risks, particularly when human activities encroach on natural habitats, placing children under five years of age – who are especially susceptible during outbreak periods – at increased risk of zoonotic infections[18].

This analysis revealed that beyond the five covariates shared by both study outcomes, under-five morbidity was uniquely associated with seven additional factors and under-five sibling mortality was uniquely associated with four additional factors. A comprehensive literature search revealed that no single study has simultaneously identified both shared risk factors and outcome-specific determinants for under-five morbidity and/or sibling mortality. The existing body of evidence has predominantly examined mortality outcomes[14,15]. Nonetheless, the results indicate that although certain determinants are associated with multiple child health outcomes, others exert outcome-specific effects, highlighting the importance of jointly examining morbidity and mortality to capture both common and unique risk factors.

Limitations

This study has several limitations. The use of cross-sectional survey data limits causal inference and the study findings may have limited generalizability beyond the sampled population. Sibling mortality was derived only for living children, excluding deceased and *non–de jure* under-fives, which may underestimate intragenerational mortality. Under-five comorbidity relied on caregiver-reported diarrhea, fever, and cough, potentially introducing recall bias and misclassification, and infections were not clinically confirmed. Some contextual and behavioral factors, such as healthcare-seeking behavior and nutritional status, were not captured, which may contribute to residual confounding, and household-level identifiers may mask individual variation. To mitigate these limitations, multivariable logistic regression was used to control for confounders, recall was limited to two weeks, symptoms were aggregated to improve comorbidity classification, and the large nationally representative DHS sample strengthened the robustness of the analysis.

CONCLUSIONS

This study highlights a substantial burden of under-five morbidity and sibling mortality in Liberia, reflecting intra-generational health vulnerabilities within households. Nearly half of children who had lost a sibling experienced multiple infections such as malaria, ARI, and diarrhea. Several determinants were identified, including shared and outcome-specific factors. Open birth intervals and maternal autonomy were associated with higher comorbidity but lower sibling mortality, while Muslim religion, mosquito-net use, and residence in North Central Liberia were protective for both outcomes. Household contact with hunted wildlife increased the risk of both outcomes. Given the cross-sectional design, further studies using longitudinal design are needed to better understand causal pathways and inform context-specific strategies to address recurrent child health risks in Liberia.

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The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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DATA AVAILABILITY

The data supporting this research are available from the following source: The Liberia Demographic and Health Survey, that is freely available to qualified researchers. To request access, please apply at DHS repository[30].

AUTHORS' CONTRIBUTIONS

IA and PR: conceived and designed the study. IA: analyzed the data with support from PR, and drafted the manuscript, with substantial contributions from PR. Both authors read and approved the final version of the manuscript.

PROVENANCE AND PEER REVIEW

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