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### RESEARCH ARTICLE

## IMPACT OF SOCIOECONOMIC FACTORS ON CHILD SURVIVAL AMONG UNDER-FIVE CHILDREN IN CONAKRY, GUINEA: DESCRIPTIVE ANALYSIS, ASSOCIATION TESTS AND PENALISED LOGISTIC REGRESSION

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#### Abstract

Under-five mortality is a key public health indicator in sub-Saharan Africa. Despite notable progress, child mortality rates in Guinea remain a concern. This study aimed to identify the socioeconomic and health factors associated with child survival among under-five children in Conakry. A cross-sectional study was conducted on 696 children. Descriptive statistics, chi-square tests, and Lasso penalized logistic regression were used to address the problem of complete separation arising from the low mortality prevalence (3.3%). Three factors were statistically significantly associated with child mortality: diarrhoea ( $\chi^2 = 393.15$ ;  $p < 0.0001$ ); case fatality rate among affected children: 60.5%, maternal education level ( $\chi^2 = 14.34$ ;  $p = 0.003$ ), and exclusive breastfeeding ( $\chi^2 = 6.57$ ;  $p = 0.010$ ). Diarrhoea is the leading determinant of child mortality in Conakry. Targeted interventions focusing on maternal education and diarrhoeal disease prevention are recommended.

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#### Introduction:-

Under-five mortality remains one of the most persistent public health challenges in sub-Saharan Africa. According to the World Health Organization (WHO, 2023), nearly 4.9 million children died before their fifth birthday in 2022, more than half of them in Africa. In Guinea, the under-five mortality rate was estimated at 92 per 1,000 live births according to the 2018 Demographic and Health Survey, reflecting a situation that, despite progress made since the 2000s, remains a serious concern (National Institute of Statistics of Guinea [NISG], 2018). The capital Conakry, despite concentrating most of the country's health infrastructure, shows significant health inequalities across its communes. Socioeconomic determinants household income, maternal education, access to healthcare interact with biological and environmental factors to shape the survival probabilities of young children. Studies from similar contexts (Mali, Niger, Senegal) have highlighted the central role of maternal education, breastfeeding quality, and infectious disease burden in determining child mortality (Mosley & Chen, 1984; Victora et al., 2008; Kandala et al., 2011).

From a methodological standpoint, statistical analysis of a rare binary outcome raises specific challenges. Standard maximum likelihood logistic regression produces biased and non-convergent estimates in the presence of complete or quasi-complete separation a common occurrence when event prevalence is very low. Penalised approaches such as Firth's method (1993) or Lasso regression offer a robust solution to this problem (Heinze & Schemper, 2002).

The objectives of this study are: first to describe the socioeconomic and health characteristics of under-five children and their mothers in Conakry, second to identify factors associated with child survival through bivariate association tests and third to quantify the effects of significant factors using penalised logistic regression.

## Materials and Methods:-

### Study population and design:

This is an analytical cross-sectional study of children under five years of age residing in Conakry. Data were drawn from the Guinea Demographic and Health Survey (DHS) of 2018 database, collected from mothers or guardians of children who attended health facilities in Conakry. The statistical unit is the child. The total sample size is N = 696 children.

### Variables:

The dependent variable is child survival (Survie\_Enf), a binary outcome: Yes = alive (1); No = deceased (0).

### Independent variables are grouped into three dimensions:

- Maternal socioeconomic factors: education level (No schooling, Primary, Secondary, Higher), poverty index (Middle, Rich, Wealthiest), wage income, access to information, marital status.
- Health service-related factors: delivery in a health facility, antenatal care visits (ANC3), distance to health facility, maternal vaccination, access to care.
- Child-level factors: sex, age, birth length and weight (low birth weight: < 2,500 g), anthropometric indices (Height/Age, Weight/Age, BMI), presence of anaemia, diarrhoea, malaria/fever, cough, exclusive breastfeeding.

### Statistical methods:

#### Analysis was conducted in three successive stages:

**Descriptive statistics:** counts and percentages for categorical variables; mean and standard deviation for continuous variables.

**Bivariate association tests:** Pearson's chi-square ( $\chi^2$ ) test to assess the association between each categorical explanatory variable and child survival. The significance threshold was set at  $\alpha = 5\%$ .

**Penalised logistic regression (Lasso):** given the low observed mortality rate (3.3%) and the complete separation problem affecting several variables (diarrhoea, BMI, anaemia), standard ML logistic regression did not converge. Lasso regularisation (L1 penalty,  $\alpha = 0.5$ ) was applied to produce stable estimates, enable automatic variable selection, and compute interpretable Odds Ratios (OR). Analyses were conducted in Python 3.12 (statsmodels 0.14, scikit-learn 1.4). Multicollinearity among explanatory variables was assessed using the Variance Inflation Factor (VIF). A VIF > 10 was taken as an indicator of problematic multicollinearity (Hair et al., 2010).

## Results:-

### Descriptive statistics:

Table 1 and Figure 1 present the main characteristics of the study population. The sample includes 696 children under five years, of whom 96.7% (n = 673) were alive and 3.3% (n = 23) had died at the time of the survey.

The mean maternal age was 28.5 years ( $\pm 6.5$  years), ranging from 15 to 49 years. Nearly half of the mothers (49.6%) had no schooling, and only 8.8% had reached higher education. Among children, 67.4% were classified as malnourished by BMI, and 87.6% had anaemia, reflecting a high disease burden in this urban disadvantaged population.

**Table 1. Socio-demographic and clinical characteristics of the study population (N = 696)**

Variable / Category	Count (n)	Percentage (%)
<b>DEPENDENT VARIABLE</b>		
Child survival — Alive (Yes)	673	96.7
Child survival — Deceased (No)	23	3.3
<b>MATERNAL EDUCATION LEVEL</b>		
No schooling	345	49.6

Primary	109	15.7
Secondary	181	26.0
Higher	61	8.8
<b>POVERTY INDEX</b>		
Middle	7	1.0
Rich	202	29.0
Wealthiest	487	70.0
<b>MATERNAL AGE</b>		
Mean $\pm$ SD	28.5 $\pm$ 6.5 years	
Range (min – max)	15 – 49 years	
<b>ETHNICITY (main groups)</b>		
Soussou	233	33.5
Peul	222	31.9
Malinke	209	30.0
<b>CHILD CLINICAL VARIABLES</b>		
Presence of diarrhoea	38	5.5
BMI — Malnourished	469	67.4
Presence of anaemia	610	87.6
Low birth weight	58	8.3
Exclusive breastfeeding (Yes)	80	11.5

Source: Guinea Demographic and Health Survey (DHS) of 2018

Figure 1. Caractéristiques descriptives de la population étudiée (N = 696, Conakry, Guinée)

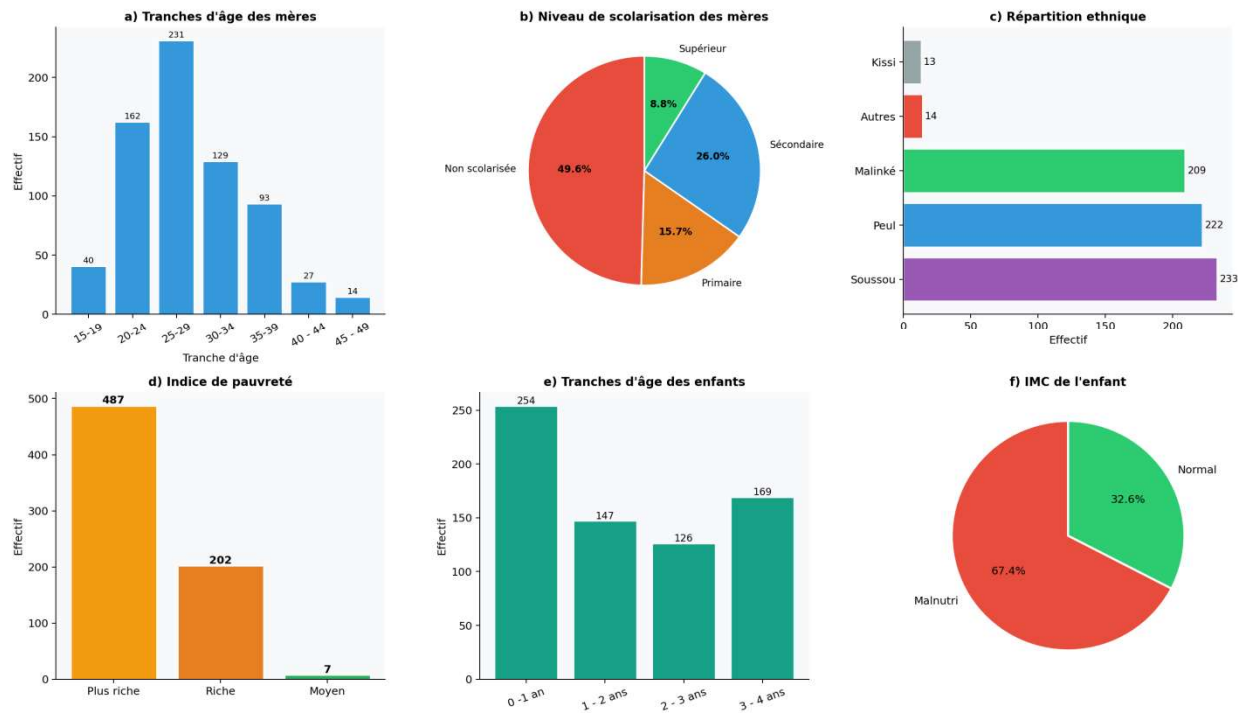


Figure 1. Descriptive characteristics of the study population — Conakry, Guinea (N = 696)

**Bivariate association tests ( $\chi^2$ ):-**

Table 2 and Figure 2 show the results of chi-square tests for each categorical variable. Three variables were statistically significantly associated with child survival at the 5% threshold.

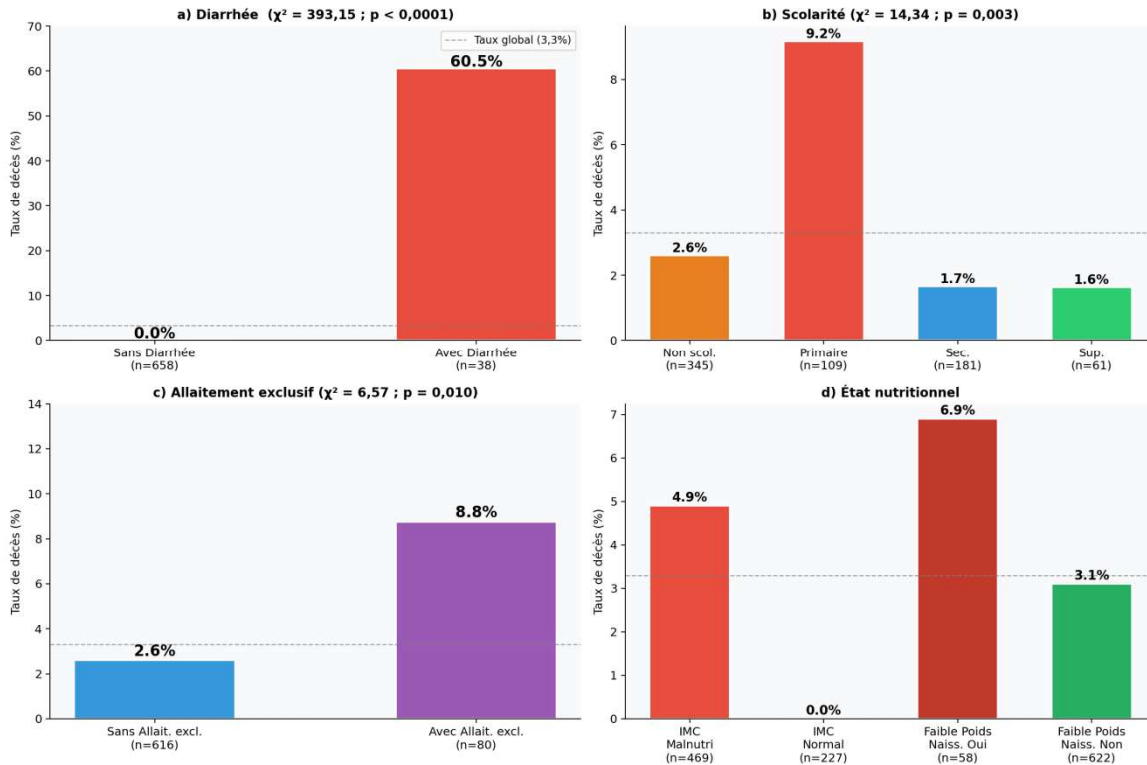
Table 2. Chi-square tests — Association with child survival

Variable	$\chi^2$	df	p-value	Conclusion
Diarrhoea	393.15	1	< 0.0001	Highly significant ***
Maternal education level	14.34	3	0.0025	Significant **
Exclusive breastfeeding	6.57	1	0.0104	Significant *
Presence of anaemia	2.28	1	0.1313	Not significant
Low birth weight	1.37	1	0.2427	Not significant
Malaria / Fever	0.91	1	0.3416	Not significant
Distance to health facility	0.66	1	0.4169	Not significant
Marital status	0.50	1	0.4801	Not significant
Poverty index	1.36	2	0.5071	Not significant
Antenatal care (ANC3)	0.17	1	0.6792	Not significant

df = degrees of freedom; \*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05; NS = not significant.

Diarrhoea was the most strongly associated factor with child mortality ( $\chi^2 = 393.15; p < 0.0001$ ). Of the 38 children with diarrhoea, 23 died a case fatality rate of 60.5% compared to 0% among the 658 children without diarrhoea. Maternal education level was also significantly associated ( $\chi^2 = 14.34; p = 0.003$ ), with a paradoxically higher mortality rate among children of mothers with primary education (9.2%) compared to those of uneducated mothers (2.6%). Exclusive breastfeeding was significantly associated with survival ( $\chi^2 = 6.57; p = 0.010$ ).

**Figure 2. Taux de mortalité selon les principaux facteurs de risque (Conakry, Guinée, N = 696)**



**Figure 2. Mortality rates by main risk factors — Conakry, Guinea**

**Multicollinearity analysis:-**

Table 3 presents Variance Inflation Factor (VIF) values for all variables included in the regression model. Several variables showed a VIF above 10, indicating structural multicollinearity: poverty index (VIF = 11.70), place of delivery (VIF = 8.94), marital status (VIF = 8.28), and birth length (VIF = 8.14). This finding justifies the use of a penalised regression method.

**Table 3. Variance Inflation Factor (VIF) of explanatory variables**

Variable	VIF	Interpretation
Poverty index	11.70	Severe multicollinearity
Delivery in health facility	8.94	Moderate multicollinearity
Birth length	8.14	Moderate multicollinearity
Marital status	8.28	Moderate multicollinearity
Antenatal care (ANC3)	7.29	Moderate multicollinearity
Presence of anaemia	7.22	Moderate multicollinearity

Distance to health facility	4.53	Acceptable multicollinearity
Child age	3.46	Acceptable
Maternal education level	2.17	Acceptable
Low birth weight	1.72	Acceptable
Exclusive breastfeeding	1.16	Acceptable

VIF > 10: severe multicollinearity ; 5 < VIF ≤ 10: moderate ; VIF ≤ 5: acceptable .

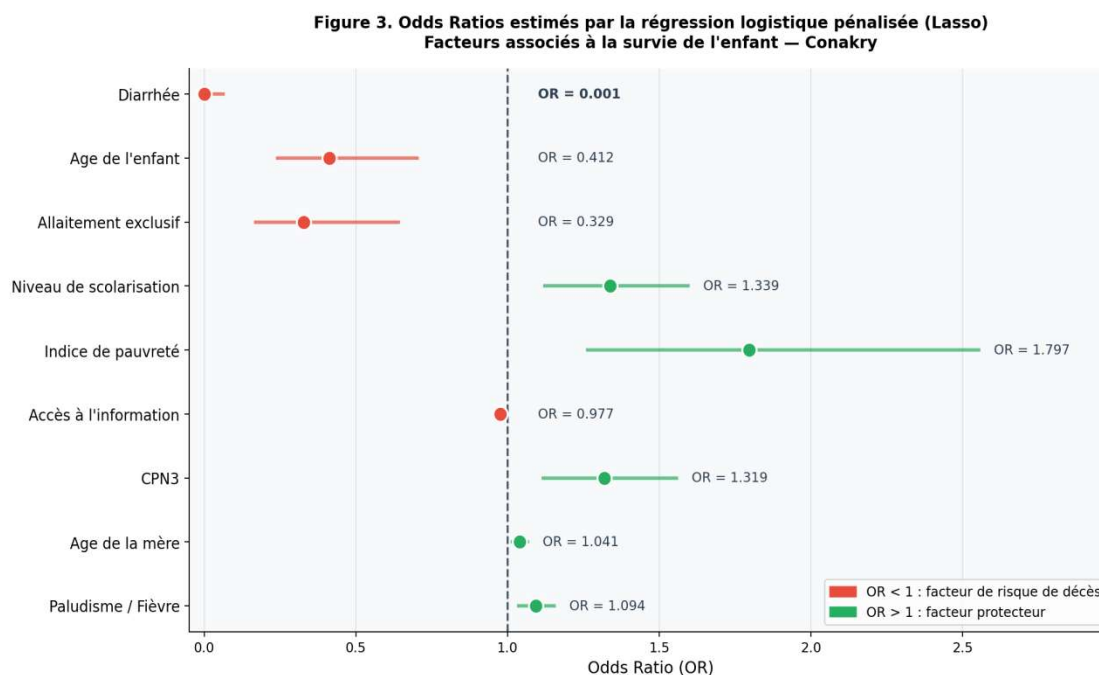
#### Penalised logistic regression:-

Due to complete separation in variables such as diarrhoea (0% deaths among children without diarrhoea), BMI (0% deaths among children with normal BMI), anaemia, and anthropometric ratios, standard ML logistic regression failed to converge. Lasso penalised logistic regression ( $\alpha = 0.5$ ) was used instead. Results are shown in Table 4 and Figure 3. Diarrhoea had a coefficient  $\beta = -6.92$  (OR = 0.001), confirming it as the primary risk factor for death. Child age had an OR of 0.412, indicating that the risk of death decreases as the child grows older. Maternal education (OR = 1.339) and poverty index (OR = 1.796) were positively associated with survival after adjustment.

**Table 4. Results of penalised logistic regression (Lasso,  $\alpha = 0.5$ )**

Variable	Coefficient $\beta$	Odds Ratio	Interpretation
<b>Diarrhoea</b>	<b>-6.92</b>	<b>+0.001</b>	Major risk factor for death ↑
Exclusive breastfeeding	-1.11	0.329	Possible selection bias (see Discussion)
SChild age	-0.89	0.412	Mortality risk decreases with age
Poverty index	+0.59	1.796	Higher income linked to better survival
Maternal education level	+0.29	1.339	Higher education protects the child
Antenatal care (ANC3)	+0.28	1.319	ANC attendance improves survival
Malaria / Fever	+0.09	1.094	Marginal positive effect after adjustment
Access to information	-0.02	0.977	No effect after penalisation

$\beta$  = regression coefficient; OR = Odds Ratio (exp( $\beta$ )); variables with  $\beta = 0$  eliminated by Lasso (not shown).



**Figure 3. Forest plot of Odds Ratios estimated by penalised logistic regression (Lasso) — Conakry**

## Discussion:-

### Diarrhoea: the dominant determinant of child mortality:-

The most striking finding of this study is the overwhelming association between diarrhoea and child mortality: 60.5% of children with diarrhoea died, compared to none of the children without it. This is consistent with the international literature. Diarrhoeal disease is the second leading cause of death among under-five children in low- and middle-income countries, responsible for approximately 525,000 deaths annually (Liu et al., 2016; UNICEF, 2023). In West Africa, unsafe drinking water, lack of sanitation, and poor hygiene practices are the main environmental determinants of diarrhoeal morbidity (Cumming & Cairncross, 2016). The extremely low OR (0.001) estimated by the Lasso model reflects quasi-complete separation in the data: no child without diarrhoea died in this sample. While this OR is not directly interpretable in a conventional sense, it confirms the robustness of the association, as corroborated by  $\chi^2 = 393.15$  ( $p < 0.0001$ ) in bivariate analysis. These findings call for urgent interventions on access to safe water and sanitation in Conakry.

### Maternal education level:-

Maternal schooling was significantly associated with child survival ( $p = 0.003$ ). This finding is consistent with the extensive literature establishing that each additional year of maternal education reduces under-five mortality by 5 to 10% (Gakidou et al., 2010; Victora et al., 2008). Education level affects the quality of childcare, a mother's ability to recognise danger signs, adherence to preventive practices (vaccination, ANC, breastfeeding), and her autonomy in health decision-making. Notably, children of mothers with only primary education had a higher mortality rate (9.2%) than those of mothers with no schooling (2.6%). This paradoxical finding, sometimes described as the 'intermediate literacy effect', may be explained by the fact that mothers with primary education have partial access to health information but lack the resources to act on it — exposing them to additional risks from ill-adapted practices (Vandemoortele & Delamonica, 2000).

### Exclusive breastfeeding: a result requiring careful interpretation:-

The significant association between exclusive breastfeeding and a higher mortality rate (8.8% vs 2.6%) is counter-intuitive and deserves careful interpretation. The scientific literature is unequivocal about the protective role of exclusive breastfeeding during the first six months of life: it reduces infant mortality by 13 to 15% in resource-limited settings (Victora et al., 2016). In a cross-sectional context, this relationship may be reversed by reverse causality bias: mothers of sick or weakened children are more likely to resort to exclusive breastfeeding as a protective strategy, creating an apparent association between breastfeeding and mortality without a direct causal link (Black et al., 2008).

**Methodological limitations:-**

This study has several limitations. First, the small number of deaths ( $n = 23$ ) limits the statistical power of multivariate analyses and generates the complete separation problem. Second, the cross-sectional design does not allow the establishment of formal causal relationships. Third, several potentially confounding variables (water quality, food storage conditions, domestic hygiene practices) were unavailable in the database. Finally, the geographic restriction to Conakry limits the generalisability of findings to the rest of Guinea.

**Recommendations:-****Public health recommendations:-**

- Strengthen diarrhoeal disease prevention and treatment programmes, particularly through improved access to safe water, sanitation, and hygiene (WASH approach) in the most vulnerable communes of Conakry.
- Develop exclusive breastfeeding promotion campaigns, coupled with child growth monitoring in primary health facilities.
- Expand girls' schooling and adult women's literacy programmes, with particular attention to reproductive health integrated into primary education.
- Improve availability of Oral Rehydration Salts (ORS) and train community health workers in the early management of childhood diarrhoea.
- Establish nutritional surveillance systems targeting children with malnourished BMI, to prevent excess mortality associated with chronic malnutrition.

**Research Recommendations:-**

- Conduct a prospective study or survival analysis (Kaplan-Meier, Cox model) including the exact date and age at death, to move beyond the limitations of the cross-sectional design.
- Increase sample size to improve the statistical power of multivariate models and enable the use of Firth's method, the reference approach in epidemiology for rare events with separation.
- Extend the study to other regions of Guinea to assess geographic disparities in child mortality and its determinants.
- Conduct mediation analyses to quantify the share of the maternal education effect that operates through intermediate health behaviours (ANC, vaccination, feeding practices).

**Conclusion:-**

This study identified the main determinants of child mortality in a sample of 696 under-five children in Conakry. Descriptively, the high prevalence of malnutrition (BMI malnourished: 67.4%) and anaemia (87.6%) reflects a heavy disease burden in this population. Analytically, three factors stood out for their statistically significant association with mortality: diarrhoea ( $\chi^2 = 393.15$ ;  $p < 0.0001$ ), maternal education level ( $\chi^2 = 14.34$ ;  $p = 0.003$ ), and exclusive breastfeeding ( $\chi^2 = 6.57$ ;  $p = 0.010$ ). Methodologically, this study demonstrates the inadequacy of ordinary least squares (OLS) regression and principal component regression (PCR) for modelling a binary outcome with low prevalence. Penalised logistic regression is the appropriate approach, capable of producing stable estimates in the presence of complete separation and multicollinearity. These findings provide a scientific basis for directing public health policy in Guinea towards targeted interventions focused on diarrhoeal disease prevention, promotion of maternal education, and improvement of nutritional coverage for under-five children.

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