**ORIGINAL RESEARCH ARTICLE**

# Socio-demographic and environmental determinants of child mortality in rural communities of Ogun State, Nigeria

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## Abstract

Nigeria's under five-mortality was 132 per 1000 in 2018. The statistic makes Nigeria the country with the third-highest under-five mortality globally. It implies that the government may not achieve the Sustainable Development Goal (SDG) of 25 per 1000 births by 2030. This situation is of grave concern to policymakers and other stakeholders interested in the country's development. This study provides unique community micro-level information on child mortality determinants in rural communities where the country's health system is weakest. The study used a sample of 1350 pregnant women aged 20-44 who attended antenatal care in22 health facilities in selected rural communities of Ogun State, South-west Nigeria. The multicollinearity diagnostics tests conducted between the dependent variable and predictors showed no abnormality in the values of the variance inflation factor, eigenvalues, and condition indexes. Logistics regression results showed that the socio-demographic characteristics such as the respondent's age, educational level, number of living children, and husband's education directly affected child mortality. In contrast, the husband has another wife had an indirect effect on child mortality. Environmental factors that directly impacted child mortality included the type of household toilet facility, source of water supply, and household waste disposal practices. These findings indicate that policies and programs to reduce child mortality in rural Nigeria must address socio-demographic and context-specific factors, especially at the community level. *(Afr J Reprod Health 2021; 25[5s]: 159-170).*

**Keywords:** Under-five mortality, socio-demographic, environmental factors, sustainable development goals

## Résumé

La mortalité des moins de cinq ans au Nigéria était de 132 pour 1000 en 2018. Cette statistique fait du Nigéria le pays avec le troisième taux de mortalité des moins de cinq ans le plus élevé au monde. Cela implique que le gouvernement pourrait ne pas atteindre l'objectif de développement durable (ODD) de 25 pour 1000 naissances d'ici 2030. Cette situation est une grave préoccupation pour les décideurs politiques et les autres parties prenantes intéressées par le développement du pays. Cette étude fournit des informations uniques au niveau micro-communautaire sur les déterminants de la mortalité infantile dans les communautés rurales où le système de santé du pays est le plus faible. L'étude a utilisé un échantillon de 1350 femmes enceintes âgées de 20 à 44 ans qui ont assisté à des soins prénatals dans 22 établissements de santé dans certaines communautés rurales de l'État d'Ogun, au sud-ouest du Nigéria. Les tests de diagnostic de multicolinéarité effectués entre la variable dépendante et les prédicteurs n'ont montré aucune anomalie dans les valeurs du facteur d'inflation de la variance, des valeurs propres et des indices de condition. Les résultats de la régression logistique ont montré que les caractéristiques sociodémographiques telles que l'âge du répondant, son niveau d'instruction, le nombre d'enfants vivants et l'éducation du mari affectaient directement la mortalité infantile. En revanche, le mari a une autre femme a eu un effet indirect sur la mortalité infantile. Les facteurs environnementaux qui ont eu un impact direct sur la mortalité infantile comprenaient le type de toilettes domestiques, la source d'approvisionnement en eau et les pratiques d'élimination des déchets ménagers. Ces résultats indiquent que les politiques et programmes visant à réduire la mortalité infantile dans les zones rurales du Nigéria doivent tenir compte des facteurs sociodémographiques et spécifiques au contexte, en particulier au niveau communautaire. *(Afr J Reprod Health 2021; 25[5s]: 159-170).*

**Mots-clés**: Mortalité des moins de cinq ans, facteurs sociodémographiques, environnementaux, objectifs de développement durable

## Introduction

he global under-five mortality rate fell to 39 deaths per 1,000 live births in 2018. Yet, children continue to face widespread regional disparities in their chances of survival, especially in sub-Saharan African countries[1]. Childhood mortality has remained a significant challenge to public health in Nigeria and other developing countries. Under-five death is a fundamental measurement of a country's quality of life, health status, and development. In 2012, approximately half the world's estimated 6.6 million deaths in children aged less than five years occurred in sub-Saharan Africa, and Nigeria accounted for about 13% of these deaths [2]. Previous studies have shown that half of the global under-five deaths occur in sub-Saharan Africa despite the region accounting for only one-fifth of the world's population of children[3,4].

Worldwide, sub-Saharan Africa has the highest under-five deaths globally, with 76 deaths per 1000, 14 times higher than the under-five mortality rate (U5MR) in developed countries[5,6]. Nigeria's present under-five mortality is the eighth in the world[7].

Notably, there has been a global decline in under-five mortality, mainly attributable to international initiatives and national programs that address the reduction of Under-5 mortality over the past years. By contrast, Nigeria is yet to maximize the positive effects of this global trend due to a lack of full comprehension of the factors affecting under-five mortality in the country. One of the United Nations' Sustainable Development Goals (SDGs) priority targets is to "end preventable deaths of newborns and under-five children by 2030"[8]. Nigeria's current under-five mortality rate of 132 deaths per 1000[9] is high when compared to the expectation of the Sustainable Development Goal (SDG) of only 25 deaths per 1000 live births by 2030. Children under the age of five years are affected by socio-demographic and environmental factors prevalent in the middle- and low-income households in developing countries, including Nigeria.

According to Emenike *et al.*[10], potable water is essential to maintain a clean environment and ensure good health. Conversely, limited access to safe drinking water supply, quality sanitation facilities, and unhealthy hygiene practices promote the spread of waterborne diseases, which causes 6.3% of the deaths recorded around the world [11]. Young children are the first to get sick and die from waterborne and sanitation-related illnesses, including diarrheal diseases and malaria[2]. The UNICEF also observed that children in sub-Saharan Africa (SSA) are 14 times more likely to die before the age of five than children from developed regions[12]. Poor environmental sanitation conditions contribute significantly to the high prevalence of infectious diseases, including malaria, cholera, typhoid, diarrhea, acute respiratory infection, and tuberculosis, among others[13]. By 2011, an estimated one billion people still used open defecation, and 185 million people relied on surface water for drinking[12].

In a study in Nigeria, Olukanni *et al.*[14] postulated that inadequate waste management and poor sanitation practices had become a significant concern in Nigeria and many developing countries in SSA. According to WHO/UNICEF[15], an estimated 9% of people worldwide lack access to potable water, and 2.4 billion cannot adequately access quality sanitation facilities despite the coordinated global efforts to actualize the SDG targets. Research evidence indicates that diarrheal illnesses in children account for the high rate of under-five mortality in Nigeria[16]. The negative consequences of household and environmental factors on under-five children's morbidity and mortality are documented well[17].

There is substantive evidence indicating that household environmental conditions such as drinking water sources, types of primary floor materials, and ambient air quality are determinants of childhood mortality[9,18,19]. Studies have also shown that mothers with formal education have reduced under-five mortality compared to those with no formal education[7,20,21]. Household environmental characteristics have a significant impact on child mortality as lower mortality rates are experienced in households with access to immunization, proper refuse and solid waste disposal facilities, and access to drinking water and sanitation facilities[4]. Potable water is essential to maintain a clean environment, ensure good health,

and a healthy nation at[10]. Children are the first to get sick and die from waterborne and sanitation-related illnesses include diarrheal and malaria diseases[2].

Providing safe drinking water and access to improved sanitation within the household environment can reduce the risk of morbidity and mortality among under-five aged children[22]. According to UNICEF and WHO reports, insufficient water, sanitation, and hygiene issues account for many illnesses. The most common waterborne disease like diarrhea, having an annual incidence of 4.6 billion episodes and cause 2.2 million deaths every year in developing countries[2]. As in many developing countries like Nigeria, socio-demographic and environmental factors are crucial to understanding the states' persistently relatively high child mortality. Literature suggests that under-five death is inversely related to mother's age; that is, as mother advances in age, child mortality rate reduces[23,24]. Mothers who attained higher educational levels had lower under-five mortality than their counterparts who had no education 24 and Under-five mortality is higher in families with limited access to drinking water.

Children born in households with inadequate toilet facilities experience the highest mortality rate (41.0%) than those born in homes with improved bathrooms (30.4%)[25]. Furthermore, Mutunga[26] reported that among the ten identified leading mortality risks in developing countries, unsafe water, sanitation, hygiene, and smoke from solid fuels were among the most threatening. Mesike and Mojekwu[4] reported that about 3% of the resulting deaths are attributable to environmental risk factors, and child deaths account for about 90% of the total deaths.

Child mortality reduction has become a common concern of all government tiers in Nigeria, non-governmental organizations, and international agencies. It is imperative to accelerate progress in preventing child deaths as current trends predict that close to 52 million under-five aged children will die between 2019 and 2030[1]. Understanding the socio-demographic and environmental factors influencing under-five mortality is significant in providing useful insights that would help formulate effective public health interventions, which can scale down the high mortality among under-five children leading to the achievement of SDG 3. It is against this background that this community-based study focused on the Ifo local government area of Ogun State. It examined socio-demographic and environmental factors influencing under-five child mortality at the community level and generating appropriate policy and programmatic actions.

## Methods

The paper was on a cross-sectional hospital-based survey data collected using a multi-stage sampling technique to select the respondents. Ifo Local Government Area (LGA) of Ogun State, Nigeria, was the study's location. The first stage of sampling involved a purposive selection of one LGA from 20 in the state. An LGA with a reasonably large population, high child mortality, and proximity to the research team's location were purposive selection criteria. In the second sampling stage, a total of 29 health facilities were in the LGA, of which 22 facilities were selected systematically with a random start and sampling fraction of 2, amounting to 75.9% of the total. This study's analysis unit was pregnant women who attended antenatal care and gave birth to at least one child in the last three years preceding the survey. Guided by the patients' list in the health facilities used as the sampling frame, pregnant women were clustered according to their clinic days. The team interviewed all women present during the clinic days that fall within the study period were interviewed.

The study team conducted fieldwork between May 1 and July 31, 2018. Overall, 1350 pregnant women respondents (6.76%) constituted the sample from a base population of 19,964 pregnant women who registered at the 29 health facilities at the time of the study. The research instrument was validated by two experts, a demographer, and health care personnel. In addition to the Cronbach Alpha index, which yielded 0.75, the data collection instrument was pretested, and questions were modified to perfect its reliability. The study adopted part of the 2013 Nigeria Demographic and Health Survey (NDHS) questionnaire to suit the local context. The structured questionnaire captured information on demographic characteristics, child mortality, and survival characteristics. The survey questionnaire was conducted by a team of experienced nurses and

matrons trained specially for the study before its commencement. Besides, they were fluent in English, Yoruba, and the local dialect of the community members.

### *Variables operationalization*

The study conceptualized that socio-demographic and environmental factors have direct and indirect relationships with child mortality. The study data obtained went through transformation and recoding using SPSS Version 20, and categorization and recoding were based mostly on available literature (e.g., NDHS categories) and the decision to reduce empty cells thus, strengthening degrees of freedom, analysis, and the results. Child mortality is the dependent variable in this study and was captured in the survey as ever lost any children aged 1-5 years and responses categorized as 1 = yes, and two = no. In this study, socio-demographic predictors of child mortality were the age of respondent, age at delivery, religion, marital status, had co-wife, education, occupation, and the number of living children. Other socio-demographic characteristics included in the study were the spouse's education and occupation.

Age of respondent was categorized as 20-24 =1, 25-30 = 2, 31-40 = 3, 30 and older = 4. Age that respondent had their first child was obtained in single years, and regrouped as 20 or less = 1, 21-24 = 2, 25-29 = 3, and 30 or older = 4. Religion was coded as traditional = 1, Islam = 2, and Christianity = 3, marital status recategorized into single/divorced/separated/widowed = 1, and married = 2, and co-wife, captured as whether husband had another wife was coded as yes= 1, no =2. Education another socio-demographic factor was recoded as none/primary = 1, secondary = 2, post-secondary/professional = 3; occupation was captured as not working = 1, self-employed = 2, civil servant = 3, and private sector employee = 4; children ever born was a continuous variable grouped as 1 or 2 = 1, 3 or 4 = 2, and 5 or more = 3; while number of living children which captures current fertility at time of survey was regrouped in similar fashion as children ever born. Other socio-demographic variables included in the study were spouse's education recorded as none/primary = 1, secondary = 2, and post-secondary/professional = 3; and spouse's occupation recorded as not working = 1, self-employed = 2, civil servant = 3, and private sector employee = 4.

Environmental predictors of child mortality are conceptualized in this study as those that affect living conditions with consequential effects on child health status. Key environmental factors considered in this study were the type of house lived in, the number of persons in a household, the type of toilet in the household, the main source of water supply, and the household waste disposal system[4]. The type of household respondent lived in was categorized as mud/grass/hut = 1, one room = 2, room and parlor = 3, two/three bedroom flat = 4, and detached house/mansion = 5. Number of persons in household was captured in single years and then categorized as 1 or 2 = 1, 3-4 = 2, 5-6 = 3, and 7 and above = 4. Type of toilet in household was measured as field/bush = 1, bucket toilet = 2, pit latrine = 3, and flush toilet = 4. Main source of household water supply was measured as river/steam =1, covered well = 2, tanker/truck = 3, borehole = 4, and tap = 5. Moreover, the household waste disposal system was measured as government collection = 1, private agency = 2, disposal within the compound (including burying and burning) = 3, and unauthorized dumpsite = 4.

## Results

### *Sample statistics*

Table 1 shows that most of the women interviewed were aged 30 or younger (61.4%), and most had their first child before reaching age 30. They were mainly Christians (59.1%), married (84.5%), and their husbands had another wife (76.2%). The majority of the respondent had secondary or higher education (85%), were self-employed (72.8%), and about half (51.7%) had three or more children alive. Most women's husbands had at least a secondary education (88.8%) and were self-employed (75.2%). On environmental factors, most study respondents and their household (68.5%) lived in a room and parlor/lower-level accommodation and were at least three persons in such housing unit (81.9%). Respondents reported that their toilets were mostly flushed (67.6%), and their primary source of water supply was borehole/tap (81.9%). Most health facilities were at trekkable distance to the respondents (75.3%). And most households of

**Table 1:** Percentage distribution of pregnant women who lost children by socio-demographic and environmental factors

| Variables | Frequency | % |
|---|---|---|
| | Total N | 1350 |
| Age of respondent | | |
| 20-24 | 283 | 21.0 |
| 25-30 | 546 | 40.4 |
| 31-40 | 391 | 29.0 |
| 41 and above | 130 | 9.6 |
| Age of respondent at delivery | | |
| 20 or less | 159 | 12.1 |
| 21-24 | 473 | 35.9 |
| 25-29 | 485 | 36.8 |
| 30 and above | 202 | 15.3 |
| Religion of respondent | | |
| Traditional | 87 | 6.5 |
| Islam | 463 | 34.4 |
| Christianity | 794 | 59.1 |
| Marital status | | |
| single-divorced-separated-widowed | 209 | 15.5 |
| Married | 1141 | 84.5 |
| Husband had another wife | | |
| Yes | 321 | 23.8 |
| No | 1029 | 76.2 |
| Education of respondent | | |
| none-primary | 203 | 15.0 |
| Secondary | 536 | 39.7 |
| post-sec-professional | 611 | 45.3 |
| Respondent occupation | | |
| not working | 147 | 14.2 |
| self-employed | 751 | 72.8 |
| civil-servant | 134 | 13.0 |
| Number of living children | | |
| 1 or 2 | 652 | 48.3 |
| 3 or 4 | 489 | 36.2 |
| 5 or more | 209 | 15.5 |
| Spouse education | | |
| none-primary | 152 | 11.3 |
| Secondary | 541 | 40.1 |
| post-sec-professional | 657 | 48.7 |
| Spouse occupation | | |
| not working | 86 | 8.3 |
| self-employed | 781 | 75.2 |
| civil-servant | 171 | 16.5 |
| Type of house living in | ` | |
| mud-grass-hut | 100 | 7.4 |
| one room | 379 | 28.1 |
| room and parlor | 445 | 33.0 |
| two-three bedroom flat | 369 | 27.3 |
| detached house-mansion | 57 | 4.2 |
| Number of persons living in a house | | |
| 2 or 1 | 243 | 18.0 |
| 3-4 | 689 | 51.0 |
| 5-6 | 353 | 26.1 |
| 7 and above | 65 | 4.8 |
| Type of toilet facility for household | | |
| field-bush/bucket toilet | 137 | 10.2 |
| pit-latrine | 300 | 22.3 |
| flush toilet | 910 | 67.6 |
| Main source of water supply | | |
| river-stream | 132 | 9.8 |
| covered well | 28 | 2.1 |
| tanker-truck | 84 | 6.2 |
| Borehole | 497 | 36.8 |
| Tap | 608 | 45.1 |
| Distance of house to health facility | | |
| not far/trekkable | 622 | 46.1 |
| far but trekkable | 394 | 29.2 |
| very far/don't know | 334 | 24.7 |
| Household waste disposal practices | | |
| govt collection | 679 | 50.3 |
| private agency | 326 | 24.1 |
| disposal within comp (burying or burning) | 236 | 17.5 |
| unauthorized dumpsite | 109 | 8.1 |
| Ever lost any child(ren) aged 1-5 years | | |
| No | 1055 | 78.2 |
| Yes | 294 | 21.8 |
| | Total N | 1350 |

respondents disposed of their waste through government/private arrangement (74.4%). About one-fifth (21.8%) of the respondents reported the death of children aged 1-5 years.

### *Bivariate results*

Table 2 shows the association between the dependent variable lost children aged 1-5 by socio-demographic and environmental factors. Chi-Square statistical technique was used to test the association between the dependent and independent variables at .1, .05, .01, and .001 levels. In Table 2 socio-demographic factors that had significant association with child mortality were age of respondent at delivery (p-value = .099), religion of respondent (p-value = .000), marital status (p-value = .001), husband had another wife (p-value = .000), education of respondent (p-value = .009), and number of living children (p-value = .000). Environmental factors associated with the death of children aged 1-5 were; the type of house lived in (p-value = .054), and household medium of waste disposal (p-value = .001).

### *Multivariate results*

A crucial step in the multivariate level analysis is collinearity diagnostics. Appendix 1 shows the test results on collinearity between socio-demographic

**Table 2:** Percentage frequency distribution of pregnant women who lost any children aged 1-5 by socio-demographic and environmental factors

| **Ever lost any child(ren) aged 1 – 5 years** | | | |
|---|---|---|---|
| **Variables** | **No (%)** | **Yes (%)** | **p-value** |
| Age of respondent | | | |
| 20-24 | 22.0 | 17.0 | |
| 25-30 | 40.7 | 39.8 | |
| 31-40 | 28.3 | 31.3 | |
| 41 and above | 9.0 | 11.9 | .140 |
| Age of respondent at delivery | | | |
| 20 or less | 12.9 | 9.0 | |
| 21-24 | 35.8 | 35.8 | |
| 25-29 | 37.0 | 36.1 | |
| 30 and above | 14.3 | 19.1 | .099 |
| Religion of respondent | | | |
| Traditional | 5.0 | 11.6 | |
| Islam | 34.8 | 32.9 | |
| Christianity | 60.1 | 55.5 | .000 |
| Marital status | | | |
| single-divorced-separated-widowed | 13.7 | 21.4 | |
| Married | 86.3 | 78.6 | .001 |
| Husband had another wife | | | |
| Yes | 21.1 | 33.0 | |
| No | 78.9 | 67.0 | .000 |
| Education of respondent | | | |
| none-primary | 14.6 | 16.7 | |
| Secondary | 41.9 | 32.0 | |
| post sec-professional | 43.5 | 51.4 | .009 |
| Respondent occupation | | | |
| not working | 14.8 | 12.0 | |
| self-employed | 72.3 | 74.5 | |
| civil-servant | 12.9 | 13.4 | .576 |
| Number of living children | | | |
| 1 or 2 | 50.9 | 39.1 | |
| 3 or 4 | 37.3 | 32.7 | |
| 5 or more | 11.8 | 28.2 | .000 |
| Spouse education | | | |
| none-primary | 11.4 | 10.9 | |
| Secondary | 39.6 | 41.5 | |
| post sec-professional | 49.0 | 47.6 | .843 |
| Spouse occupation | | | |
| not working | 8.5 | 7.4 | |
| self-employed | 74.9 | 76.4 | |
| civil-servant | 16.6 | 16.2 | .842 |
| Type of house living in | | | |
| mud-grass-hut | 6.4 | 11.2 | |
| one room | 28.2 | 27.9 | |
| room and parlor | 34.1 | 28.9 | |
| two-three bedroom flat | 27.2 | 27.6 | |
| detached house-mansion | 4.2 | 4.4 | .054 |
| Number of persons living in a house | | | |
| 2 or 1 | 18.8 | 15.3 | |
| 3-4 | 51.6 | 49.3 | |
| 5-6 | 24.9 | 30.6 | |
| 7 and above | 4.7 | 4.8 | .204 |
| Type of toilet facility for household | | | |
| field-bush/bucket toilet | 10.3 | 9.6 | |
| pit-latrine | 21.9 | 23.5 | |
| flush toilet | 67.8 | 66.9 | .816 |

| **Ever lost any child(ren) aged 1 – 5 years** | | | |
|---|---|---|---|
| **Variables** | **No (%)** | **Yes (%)** | **p-value** |
| Main source of water supply | | | |
| river-stream | 10.0 | 9.2 | |
| covered well | 1.7 | 3.4 | |
| tanker-truck | 5.7 | 7.8 | |
| Borehole | 37.1 | 36.1 | |
| Tap | 45.5 | 43.5 | .259 |
| Distance of house to health facility | | | |
| not far/trek able | 46.8 | 43.2 | |
| far but trek able | 29.0 | 29.9 | |
| very far/don't know | 24.2 | 26.9 | .496 |
| Household waste disposal practices | | | |
| govt collection | 49.5 | 53.4 | |
| private agency | 25.3 | 20.1 | |
| disposal within comp (burying or burning) | 18.5 | 13.6 | |
| unauthorized dumpsite | 6.7 | 12.9 | .001 |
| | Total N | 1350 | |

**Table 3:** The odds that pregnant women lost any children by socio-demographic and environmental determinants

| | **Model 1 (only socio-demographic factors)** | | | | **Model 3 (All predictors)** | | | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | **Exp(B)** | **Lower** | **Upper** | **Sig.** | **Exp(B)** | **Lower** | **Upper** | **Sig.** |
| **Socio-demographic factors** | | | | | | | | |
| Age of respondent | | | | | | | | |
| 20-24 | 1.00 | | | | 1.00 | | | |
| 25-30 | 1.454 | .874 | 2.419 | .149 | 1.421 | .840 | 2.406 | .190 |
| 31-40 | 1.874 | 1.083 | 3.244 | .025 | 1.799 | 1.016 | 3.185 | .044 |
| 41 and above | .825 | .375 | 1.812 | .632 | .796 | .354 | 1.792 | .582 |
| Age of respondent at delivery | | | | | | | | |
| 20 or less | 1.00 | | | | 1.00 | | | |
| 21-24 | 1.385 | .729 | 2.633 | .320 | 1.304 | .676 | 2.515 | .429 |
| 25-29 | 1.135 | .580 | 2.222 | .712 | 1.102 | .554 | 2.194 | .782 |
| 30 and above | 1.296 | .595 | 2.822 | .514 | 1.233 | .551 | 2.760 | .610 |
| Religion of respondent | | | | | | | | |
| Traditional | 1.00 | | | | 1.00 | | | |
| Islam | .608 | .319 | 1.158 | .130 | .525 | .268 | 1.029 | .061 |
| Christianity | .702 | .369 | 1.336 | .281 | .582 | .296 | 1.141 | .115 |
| Marital status | | | | | | | | |
| single-divorced-separated-widowed | 1.00 | | | | 1.00 | | | |
| Married | .754 | .473 | 1.203 | .237 | .796 | .487 | 1.299 | .360 |
| Husband had another wife | | | | | | | | |
| Yes | 1.00 | | | | 1.00 | | | |
| No | .611 | .400 | .934 | .023 | .577 | .370 | .901 | .016 |
| Education of respondent | | | | | | | | |
| none-primary | 1.00 | | | | 1.00 | | | |
| Secondary | .692 | .408 | 1.173 | .171 | .658 | .379 | 1.141 | .136 |
| post sec-professional | 1.360 | .749 | 2.468 | .312 | 1.367 | .735 | 2.541 | .324 |
| Respondent occupation | | | | | | | | |
| not working | 1.00 | | | | 1.00 | | | |
| self-employed | 1.009 | .578 | 1.760 | .975 | .920 | .518 | 1.637 | .778 |
| civil-servant | 1.031 | .484 | 2.195 | .938 | .895 | .408 | 1.967 | .783 |
| Number of living children | | | | | | | | |
| 1 or 2 | 1.00 | | | | 1.00 | | | |
| 3 or 4 | .986 | .653 | 1.488 | .946 | .906 | .585 | 1.403 | .659 |
| 5 or more | 3.095 | 1.979 | 4.841 | .000 | 2.875 | 1.748 | 4.727 | .000 |
| Spouse education | | | | | | | | |
| none-primary | 1.00 | | | | 1.00 | | | |
| Secondary | 1.694 | .929 | 3.088 | .085 | 1.743 | .936 | 3.246 | .080 |
| post sec-professional | 1.464 | .747 | 2.872 | .267 | 1.436 | .711 | 2.900 | .313 |

| Variable | Model 1 (only socio-demographic factors) Exp(B) | Lower | Upper | Sig. | Model 3 (All predictors) Exp(B) | Lower | Upper | Sig. |
|---|---|---|---|---|---|---|---|---|
| Spouse occupation | | | | | | | | |
| not working | 1.00 | | | | 1.00 | | | |
| self-employed | 1.314 | .652 | 2.648 | .445 | 1.311 | .631 | 2.727 | .468 |
| civil-servant | 1.006 | .441 | 2.293 | .989 | 1.059 | .447 | 2.511 | .897 |
| | **Model 2** | | | | | | | |
| | **Exp(B)** | **Lower** | **Upper** | **Sig.** | | | | |
| Type of house living in | | | | | | | | |
| mud-grass-hut | 1.00 | | | | 1.00 | | | |
| one room | .617 | .373 | 1.020 | .060 | .817 | .419 | 1.593 | .553 |
| room and palour | .501 | .304 | .828 | .007 | .830 | .416 | 1.655 | .597 |
| two-three bedroom flat | .568 | .338 | .955 | .033 | .778 | .369 | 1.643 | .511 |
| detached house-mansion | .592 | .272 | 1.292 | .188 | .660 | .205 | 2.124 | .486 |
| Number of persons living in the house | | | | | | | | |
| 2 or 1 | 1.00 | | | | 1.00 | | | |
| 3-4 | 1.256 | .856 | 1.844 | .244 | 1.107 | .664 | 1.846 | .696 |
| 5-6 | 1.736 | 1.139 | 2.646 | .010 | 1.733 | .970 | 3.095 | .063 |
| 7 and above | 1.226 | .610 | 2.463 | .567 | .648 | .262 | 1.598 | .346 |
| Type of toilet facility for household | | | | | | | | |
| field-bush/bucket toilet | 1.00 | | | | 1.00 | | | |
| pit-latrine | 1.474 | .868 | 2.503 | .151 | 2.104 | 1.037 | 4.271 | .039 |
| flush toilet | 1.400 | .848 | 2.312 | .188 | 2.506 | 1.269 | 4.950 | .008 |
| Main source of water supply | | | | | | | | |
| river-stream | 1.00 | | | | 1.00 | | | |
| covered well | 2.144 | .862 | 5.330 | .101 | 1.545 | .539 | 4.428 | .418 |
| tanker-truck | 1.454 | .734 | 2.880 | .283 | 1.233 | .520 | 2.923 | .635 |
| Borehole | 1.033 | .621 | 1.718 | .901 | .773 | .419 | 1.429 | .412 |
| Tap | 1.008 | .618 | 1.643 | .975 | .752 | .419 | 1.350 | .340 |
| Distance of house to health facility | | | | | | | | |
| not far/trekkable | 1.00 | | | | 1.00 | | | |
| far but trekkable | 1.182 | .862 | 1.620 | .300 | 1.122 | .730 | 1.727 | .599 |
| very far/don't know | 1.132 | .810 | 1.581 | .467 | 1.111 | .714 | 1.730 | .640 |
| Household waste disposal practices | | | | | | | | |
| govt collection | 1.00 | | | | 1.00 | | | |
| private agency | .754 | .537 | 1.059 | .104 | .819 | .525 | 1.278 | .379 |
| disposal within comp (burying or burning) | .615 | .411 | .920 | .018 | .652 | .383 | 1.109 | .114 |
| unauthorised dumpsite | 1.843 | 1.171 | 2.900 | .008 | 1.671 | .902 | 3.095 | .103 |

**Note:** Level of Significance; .*p ≤ .05, **p ≤ .01, ***p ≤.001.
**Model 1**: Chi-square = 61.192, -2 Log likelihood = 834.359[a], Nagelkerke R Square = .106
**Model 2:** Chi-square = 38.560, -2 Log likelihood = 1371.445[a], Nagelkerke R Square = .044.
**Model 3**: Chi-square = 83.665, -2 Log likelihood = 810.942[a], Nagelkerke R Square = .143

and environmental factors. Except in a few cases, i.e., six of 256 variance proportion values, the majority were less than .5, and results of statistical test significant. None of the six variance proportion values were corroborated by results of other collinearity indicators, i.e., VIF, CI, Eigenvalues, and tolerance.

Table 3 (Model 1) examined relationships between the dependent variable, lost any children aged 1-5, and socio-demographic predictors. Model 2 presents the relationships between the dependent variable and only environmental factors. Model 3 shows the relationships between the dependent variable and socio-demographic and environmental factors both included in the equation**.** Thus, the three blocks of models enabled teasing out direct and indirect effects of socio-demographic and environmental predictors of child mortality. The strength of the relationships regarding point estimates was tested at four levels-- .1, .05, .01, and

.001. Also, confidence intervals in Table 3 depict the range of acceptance of the estimated population parameters at 95% confidence. The summary results for the three models are presented in the last panel of Table 3. The results showed that Model 3 compared with Models 2 and 1 is best fitted with a higher Chi-square value (83.67, vs. 38.56 and 61.19, respectively), and lowest -2 log-likelihood (810.94 vs. 1371.44 and 834.36, respectively), and a higher proportion of explained variation (14.3% vs. 11%, and 4.4%, respectively).

This section's findings focussed mainly on significant outcomes in Model 3 of Table 3, which is the best fit and has all explanatory variables. Model 3 shows that child mortality had indirect relationships with the type of house lived in and household waste disposal practices. Moreover, child mortality directly links with respondent age, religion; the husband had another wife, number of living children, husband's education, number of persons who lived in the house, and type of toilet facility for respondents' household.

### *Relationships between child mortality and socio-demographic factors*

The odds of child mortality were about two times higher for respondents aged 31-40 compared to their younger counterparts aged 20-24 (OR = 1.79, [CI = 1.02, 3.18]). The odds of losing children was significantly lower for Muslim respondents compared to their traditionalist counterparts (OR = .525, [CI = .268, 1.03]), and it was lower for those whose' husband had another wife compared to their traditionalist counterpart (OR = .577, [CI = .370, .901]). As expected, the odds of child mortality were higher for respondents who had five or more living children than those with only one or two living children (OR = 2.87, [CI = 1.75, 4.73]). The odds of child mortality were higher for women whose husbands had secondary education compared to those whose husbands had none or primary (OR = 1.74, [CI = .936, 3.25]).

### *Relationships between child mortality and environmental determinants*

Concerning environmental factors, findings showed that the odds of child mortality were about twice for respondents who reported having five or six persons in their household than their counterparts who reported two or one (OR = 1.73, [CI = .970, 3.09]). The relationship between child mortality and type of toilet facility in the household was contrary to expectation. The odds of child mortality for respondents with pit-latrine was twice that of their counterparts who used field-bush/bucket as toilet facility (OR = 2.10, [CI = 1.04, 4.27]). Also, the odds of a child aged 1-5 dying for respondents who used a flush toilet in their household was 2.5 times compared to their colleagues who used field-bush/bucket as a waste facility (OR = 2.51 [CI = 1.27, 4.95]).

## Discussion

This study examined socio-demographic and environmental factors influencing child mortality in a rural context in Nigeria, where evidence of this nature is rare and virtually non-existent. It conducted a hospital-based study collecting health and related information from 1350 pregnant women attending an ante-natal clinic at the survey time. Findings provide insights into direct and indirect socio-demographic and environmental factors affecting child mortality among the communities studied. The importance of these results for programming is prioritizing intervention for what should come first by order of importance and perhaps impact**.** Factors that directly affected child mortality were the respondent's age, religion, family type (monogamous vs. polygamous), number of living children, and husband's education. Other independent variables that directly affect child mortality are the number of persons in a house and the type of household toilet facility. These predictors of child mortality should be considered before other factors like the type of home lived in and household disposal practices that have indirect effects on child mortality**.** The distinction between direct and indirect predictors of child mortality is a unique contribution of this paper. The findings that directly affect child mortality may likely be more efficient in reducing child mortality than the indirect effects. Thus, policy and program implementation should be prioritized, considering factors with direct effects before those with indirect effects. Age of respondents, religion, no of co-wives, the number

of living children, spouse's education are socio-demographic factors that should be considered in a future intervention with the objective of child mortality reduction in the locality and perhaps other rural communities in the country**.** Policy and program intervention need to target older women, especially those who have many children, with information that will encourage them to take good care of their children, especially those aged between one and five. It will be necessary to customize program intervention based on region and focus more on traditional women to change their behavior on better care for their children. It was entirely unexpected that spouses' education had adverse effects on child mortality, and women's education was not significant as in other studies[7,20]. The results may be due to male hegemony and influence in a typical Nigerian household, especially in the rural areas. Thus, the decisions of educated men in community settings are perhaps, more respected than those of their counterparts who were not educated. Further research will be necessary to shed more insights into this unexpected negative outcome of this study.

A critical environmental predictor of child mortality in this study is the number of persons living in a household. The number of persons in a house is an indicator of density or crowded home, which implies more pressure on available resources and facilities such as potable water[26] and increased risk factors including poor hygiene and unclean environment [4,10]. In this circumstance, children can easily be at the receiving end of the ladder, resulting in increased mortality risk[25]. Policy and programs should address this issue by educating families on the danger of overcrowded households and the possible consequences. Also, government decision-makers at the state level and other interested stakeholders should increase access to affordable housing, potable water, and other amenities at the community level, thus, improving quality of life and reduce child mortality in the long-run.

Another interesting finding of this study is that women who reported that their home has flush toilets had higher odds of child mortality than their counterparts who defecated in the field/bush or used bucket toilets. While this paper may not provide specifics on the reasons for this result, it is appropriate to note that the result is suggestive that while having a flushed toilet may be necessary for a household, it is not sufficient to attain good hygiene. Anecdotal evidence suggests that households in rural communities of this study are likely to have more flushed toilet facilities without adequate water supply than with water supply. Therefore, for the dividends of using the flushed toilet to be realized in households in such rural settings, it will be necessary to complement a constant and adequate supply of water to ensure that flushed toilets are clean at all-time[9,10,18,19]. Otherwise, the flushed toilets may serve as sources of diarrhea, one of the killer diseases of children[10]. One limitation of this study is that the water supply source's information was not enriched by constant water supply or household utilization information. Studies in the literature have examined unsafe water and its negative impact on child mortality[10,26-32]; what is yet to be teased out or to receive significant attention is the relationships between the flushed toilet, water supply, and child mortality. Policy and program intervention geared to achieving SDG 3.2 by 2030 must ensure adequate supply and access to portable water supply[33,34] in Ogun State and Nigeria's rural communities.

## Ethical consideration

The research team got approval from the Covenant University management to conduct the study. The team also applied to the Ifo Local Government Area (LGA) Chairman and was given tacit approval to conduct the study in the selected health facilities in the LGA. The study did not involve any activity that may cause harm or risk to human life. However, the study team applied standard research ethics, including informed consent, willingness to participate, and anonymity of the respondent.

## Conclusion

This study examined vital socio-demographic and environmental factors affecting child mortality in selected rural communities in Nigeria. The main factors to improve child mortality in the household are direct and indirect, based on their predictive paths. The indirect factors are the type of house lived-in and household waste disposal practices. The direct predictors of child mortality for intervention purposes are the age of women,

religion, kind of marriage, number of living children, husband's education, and type of household toilet facility. These direct factors should be given priority in policies and programming focused on improving child mortality in rural areas in Nigeria. Prioritizing programs based on the direct and indirect factors influencing child mortality will go a long way to achieving SDG 3.2, which focuses on ending newborn and child mortality in the country by 2030.

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# Appendix

**Appendix I:** Collinearity Diagnostics on number of children ever lost aged 1-5 by socio-demographic and environmental factors

| **Variance Proportions** | | | | | | | | | | | | | | | | | Sig | Tol. | VIF | Eigen value | Cond index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | | | | | |
| 1. | .03 | .00 | .00 | .00 | .01 | .02 | .00 | .08 | .01 | .00 | .01 | .02 | .01 | .02 | .02 | .27 | .962 | .793 | 1.261 | .261 | 7.709 |
| 2. | .09 | .04 | .00 | .00 | .00 | .00 | .00 | .16 | .00 | .00 | .00 | .01 | .00 | .00 | .07 | .35 | .426 | .820 | 1.220 | .204 | 8.731 |
| 3. | .01 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .01 | .00 | .00 | .01 | .78 | .18 | .480 | .849 | 1.178 | .166 | 9.671 |
| 4. | .20 | .12 | .00 | .00 | .00 | .00 | .00 | .45 | .00 | .00 | .00 | .00 | .00 | .02 | .02 | .03 | .067 | .894 | 1.118 | .141 | 10.478 |
| 5. | .02 | .02 | .03 | .00 | .01 | .05 | .00 | .00 | .04 | .00 | .16 | .23 | .00 | .15 | .00 | .00 | .116 | .778 | 1.286 | .110 | 11.867 |
| 6. | .00 | .04 | .00 | .01 | .00 | .08 | .00 | .22 | .05 | .00 | .00 | .43 | .01 | .06 | .00 | .06 | .132 | .586 | 1.705 | .099 | 12.537 |
| 7. | .00 | .00 | .09 | .01 | .07 | .01 | .00 | .00 | .01 | .00 | .30 | .05 | .00 | .30 | .03 | .01 | .624 | .823 | 1.215 | .083 | 13.651 |
| 8. | .05 | .00 | .00 | .01 | .00 | .07 | .23 | .00 | .05 | .10 | .04 | .04 | .00 | .24 | .00 | .02 | .000 | .902 | 1.108 | .075 | 14.432 |
| 9. | .48 | .63 | .01 | .00 | .00 | .00 | .02 | .00 | .03 | .02 | .01 | .03 | .00 | .00 | .02 | .00 | .682 | .591 | 1.692 | .072 | 14.661 |
| 1( | .06 | .01 | .05 | .00 | .04 | .07 | .14 | .01 | .01 | .04 | .27 | .08 | .12 | .13 | .01 | .00 | .849 | .820 | 1.219 | .066 | 15.313 |
| 1: | .00 | .00 | .04 | .01 | .09 | .02 | .00 | .01 | .00 | .00 | .18 | .00 | .81 | .03 | .00 | .02 | .491 | .759 | 1.317 | .050 | 17.550 |
| 1: | .00 | .05 | .61 | .08 | .24 | .04 | .07 | .00 | .05 | .01 | .02 | .00 | .00 | .00 | .00 | .00 | .891 | .880 | 1.137 | .042 | 19.232 |
| 1: | .00 | .01 | .00 | .28 | .03 | .00 | .21 | .00 | .01 | .61 | .00 | .01 | .00 | .00 | .00 | .00 | .034 | .818 | 1.223 | .036 | 20.705 |
| 1- | .02 | .02 | .05 | .00 | .11 | .61 | .00 | .00 | .71 | .01 | .00 | .00 | .00 | .00 | .01 | .00 | .187 | .908 | 1.101 | .036 | 20.863 |
| 1! | .00 | .00 | .00 | .39 | .38 | .04 | .30 | .00 | .02 | .16 | .00 | .02 | .01 | .00 | .00 | .01 | .298 | .963 | 1.038 | .032 | 21.865 |
| 1( | .02 | .04 | .11 | .18 | .01 | .00 | .02 | .06 | .00 | .06 | .01 | .05 | .02 | .05 | .04 | .03 | .606 | .933 | 1.072 | .009 | 42.238 |

**Note:** Adjusted R Square = .029, Std. Error of the Estimate = .40190; Dependent Variable: ever lost any child(ren) aged 1-5 years; 1 = age of respondent, 2 = age of respondent at delivery, 3 = religion of respondent, 4 = marital status, 5 = husband had another wife, 6 = education of respondent, 7 = respondent occupation, 8 = number of living children 9 =spouse education , 10 = spouse occupation 11 = type of house living in , 12 = number of persons living in house, 13 = type of toilet facility for household, 14 = main source of water supply, 15 = distance of house to health facility, 16 = household waste disposal practices