**Original Article**

# Social determinants of health associated with hypoglycemia and outcomes among children in northwestern Nigeria: A cross-sectional Study

Olayinka Rasheed Ibrahim *[1], Amudalat Issa [2], Jubril Fikayomi Abdulkarem [3], Taofeek Babatunde Rafiu [4]

[1] Department of Pediatrics, Division of Clinical Medicine, University of Global Health Equity, Kigali, Rwanda.
[2] Department of Pediatrics, Children Specialist Hospital, Ilorin, Nigeria
[3] Department of Medicine and Surgery, University of Ilorin, Ilorin, Nigeria.
[4] Department of Pediatrics, Federal Teaching Hospital, Katsina, Nigeria.

**Corresponding author and reprints: Olayinka Rasheed Ibrahim**, Assistant Professor, Department of Pediatrics, Division of Clinical Medicine, University of Global Health Equity, Kigali, Rwanda.
**Email:** ibroplus@gmail.com.ir

**Received:** 30 Apr 2024 **Accepted:** 06 Jan 2025 **Published:** 15 Feb 2025

## Abstract

**Background:** Social determinants of health (SDH) are an emerging concept with significant influence on health and may have an impact on children presenting with acute illnesses including those with hypoglycemia. Herein, we explored the relationship between SDH and the prevalence of hypoglycemia and outcomes among children presenting with acute emergencies in northwestern Nigeria.

**Methods:** This was a descriptive cross-sectional study of children admitted into the emergency ward of a tertiary hospital in Nigeria. At the presentation, we obtained socio-demographics, clinical features, diagnosis, random blood sugar, and outcomes (duration of hospitalization, death or discharged) and analyzed them with SPSS.

**Results:** We included 597 children with a median (interquartile range) age of 3.5 (1.3 to 8) years. Most children were under 5 (337; 56.64%), and males (328; 54.9%). Most mothers of the children included had no formal education, 76.7% (458). The prevalence of hypoglycemia (< 2.8 mmol/L) was 8.2% (49/597), with a 99% confidence interval (CI) of 6.3 to 10.7%. Based on the age, children aged 13 to 59 months had the highest prevalence of hypoglycemia (11.0%) with 99% CI of 7.4 to 16.1%. At presentation, gender, parents' occupations, parents' education levels, and socio-economic classes were not associated with hypoglycemia. The case fatality rate for hypoglycemia was 16.3% (8/49), which was higher than children without hypoglycemia (4.1%; 20/482), p<0.05.

**Conclusion:** This study shows that among the SDH evaluated, only children aged 13–59 months were associated with hypoglycemia. In addition, the presence of hypoglycemia increased the odds of death by 4.5.

**Keywords: child; hypoglycemia; Social factors.**

**Cite this article as**: Olayinka RI, Amudalat I, Jubril Fikayomi A, Taofeek Babatunde R. Social determinants of health associated with hypoglycemia and outcomes among children in northwestern Nigeria: A cross-sectional Study. *Soc Determinants Health*. 2025;11(1):1-11. DOI: http://dx.doi.org/10.22037/SDH.v11i1.44972

## Introduction

Hypoglycemia remains the most frequent metabolic emergency in sick children, with possible neurological damage, including long-term cognitive impairment, if not promptly identified and treated (1,2). This is because maintaining a proper blood glucose level is crucial for optimal brain development and

function, where it serves as a necessary metabolic substrate for cerebral energy metabolism (3). Hypoglycemia is a common occurrence in children due to multiple factors; including less effective glucose homeostasis, dysregulated physiologic events that are associated with many childhood illnesses, and a reduction in oral intake seen in most sick children (4,5). Thus, it is a frequent presentation in common childhood conditions, including malnutrition, respiratory illnesses, malaria, acute diarrhea disease, and sepsis (5–7).

Whereas the literature has investigated the association of hypoglycemia with many diseases, an area that remains unclear is the role of non-medical conditions that may influence the blood sugar levels of a sick child, including social determinants of health (8). Social determinants of health (SDH) are an emerging concept that describe the non-medical factors influencing health outcomes (9). The SDH influences the health of individuals, including children, birth origin, age, growth, education, occupation, living conditions, and the broader array of influences and systems shaping everyday life conditions (9). Despite the fact that SDH influences access to health care, quality of life, living conditions, and a child's overall well-being, very few studies on the impacts of social determinants on health in children focused on chronic diseases like diabetes and other non-acute medical conditions (10–14). Thus, we sought to investigate the prevalence of hypoglycemia and its relationship with social determinants (age, sex, parents' educational levels, parents' occupation, and socio-economic class) and outcomes among children admitted to a pediatric emergency ward in a tertiary health facility in Northwestern Nigeria. This study comprehensively analyzed the various factors in the social context that contribute to the occurrence of hypoglycemia in this population. Additionally, we also shed light on the hypoglycemia and hospitalization outcomes (death or discharged).

## Methods

### *Study design and settings*

This was a cross-sectional descriptive study of pediatric cases managed at a tertiary health facility in northwestern Nigeria from July 1st, 2019, to November 30th, 2019. The hospital is a referral center for other hospitals within the state and surrounding neighboring states of Kano, Kaduna, Zamfara, and parts of the Niger Republic. The hospital has an emergency pediatric complex with a 24-bed capacity that also includes a two-bed high-dependent unit for critically ill children who need close monitoring. The children's emergency is headed by a consultant pediatrician and supported by residents and nurses.

### *Sample size estimations*

The minimum sample size was estimated using a prevalence of hypoglycemia of 22.1% obtained in a study in northwestern Nigeria (15). We estimated a minimum sample size of 447 at a 5% level of precision and a 99% confidence. The online sample size calculator (http://www.raosoft.com/samplesize.html) was used for the sample size estimation.

### *Inclusion and exclusion criteria*

This study included children between the ages of 1 month and 14 years who were admitted into the emergency pediatric ward of the hospital. We excluded children with a diagnosis of malignancies, those that discharged against medical advice by their parents, and those with known diabetes mellitus, who received intravenous fluids within 24 hours before presentation.

### *Participants recruitment and blood glucose determinations*

The children who fulfilled the study inclusion criteria were consecutively recruited until the minimum sample size was achieved. We measured the blood glucose (mmol/L) at the point of presentation at the children's emergency unit using an AccuChek® Active blood glucose meter. In brief, at the presentation,

each child had a finger prick using the index finger, and a drop of blood was applied to the blood glucose meter with a strip already inserted, and results were read immediately. In this case of an error, the process was repeated, and the obtained values were recorded in the study proforma.

***Patients' management***.

All patients with hypoglycemia received an immediate infusion of an intravenous bolus of 2 ml/kg body weight (BW) of 10% glucose water, followed by a continuous dextrose infusion at 6–8 mg/kg/min based on the department protocol for managing hypoglycemia. After that, the blood glucose was monitored closely until at least two consecutive normal values were obtained. In addition, all the children received other standards of care based on their diagnosis using the institution's protocols and guidelines.

***Definition of terms***

Hypoglycemia was defined as random blood glucose less than 2.8 mmol/l (50 mg/dl), euglycemia as random glucose between 2.8 to 8.3 mmol/L, and hyperglycemia as values greater than 8.3 mmmol/L (5,16).

***Socio-economic status***

The socio-economic status of the parents of the study children was determined using the 'Oyedeji social classification index', derived from the average of the sum of the highest education levels attained by the parents and their occupations (17). In brief, those with a university degree or its equivalent received a score of 1, those with post-secondary education but not up to a university degree received a score of 2, those with a senior secondary certificate received a score of 3, those with a primary level of education received a score of 4, and those without any formal education received a score of 5. For the occupation classification, we scored 1 for senior public civil servants, professionals, managers, large-scale traders, businessmen, and contractors, 2 for intermediate-grade public servants and senior school teachers, 3 for junior school teachers, professional drivers, and artisans, 4 for petty traders, laborers, and messengers, and 5 for those who are unemployed, full-time housewives, students, and subsistence farmers. We rounded the mean scores from the education levels and occupational classes to the nearest whole number and further classified them as follows: Scores of 1 and 2 as upper socio-economic class, scores of 3 as middle socio-economic class, and scores of 4 and 5 as low socio-economic class (17).

***Study outcomes***

The primary objective of this study was to assess the prevalence of hypoglycemia and its relationship with SDH (age, gender, parents' educations, parents' occupations, and socio-economic status).The other secondary objective was to explore the relationship between the prevalence of hypoglycemia and hospitalization outcomes (discharge or death) among the children.

***Data collections***

The data were collected using a semi-structured questionnaire after obtaining informed consent from the parents and caregivers. Data collected included the age, sex, date of admission, duration of illness before admission, parents' educations and occupations, clinical features including the diagnosis, outcomes (discharged or death), date of outcomes, and values of random blood glucose obtained at the point of admission.

***Ethical consideration and approval***

This study was conducted per the Declaration of Helsinki. Informed consent was obtained from the parents and caregivers after a detailed explanation of the study. The Health Research Ethics Committee of the Federal Teaching Hospital Katsina approved this study. The data were kept on a secured password

computer, and the information obtained was maintained with absolute confidentiality.

### *Statistical analysis*

The data was extracted and analyzed using IBM SPSS Statistics for Windows, version 25.0. (IBM Corp., Armonk, N.Y., USA). The age and blood glucose at presentation were not normally distributed and summarized with a median and an interquartile range (IQR). The socio-demograhic variables and categories of diagnosis were summarized with frequency tables. The prevalence of hypoglycemia among the study children was expressed as percentage along with 99%. The associations between SDH, hypoglycemia, and outcomes were evaluated using a Chi-square and G-test as appropriate and odds ratio along with 95% confidence intervals (CI). The main outcome (dependent variable was the prevalence of hypoglycemia among the study children) while the independent variables were age, sex, parents' educational levels, occupation of the parents, their socio-economic class and duration of hospitalization. The associations were expressed as odds ratio along with 95% CI. For all levels of statistical significance, the *p*-value was set at 0.05.

## Results

A total of 853 children aged 1 to 14 months were seen at the EPU during the study, and 256 were excluded for not fulfilling the study's inclusion criteria. A total of 597 children had their random blood sugar done at admission were included in the final study (Figure 1).

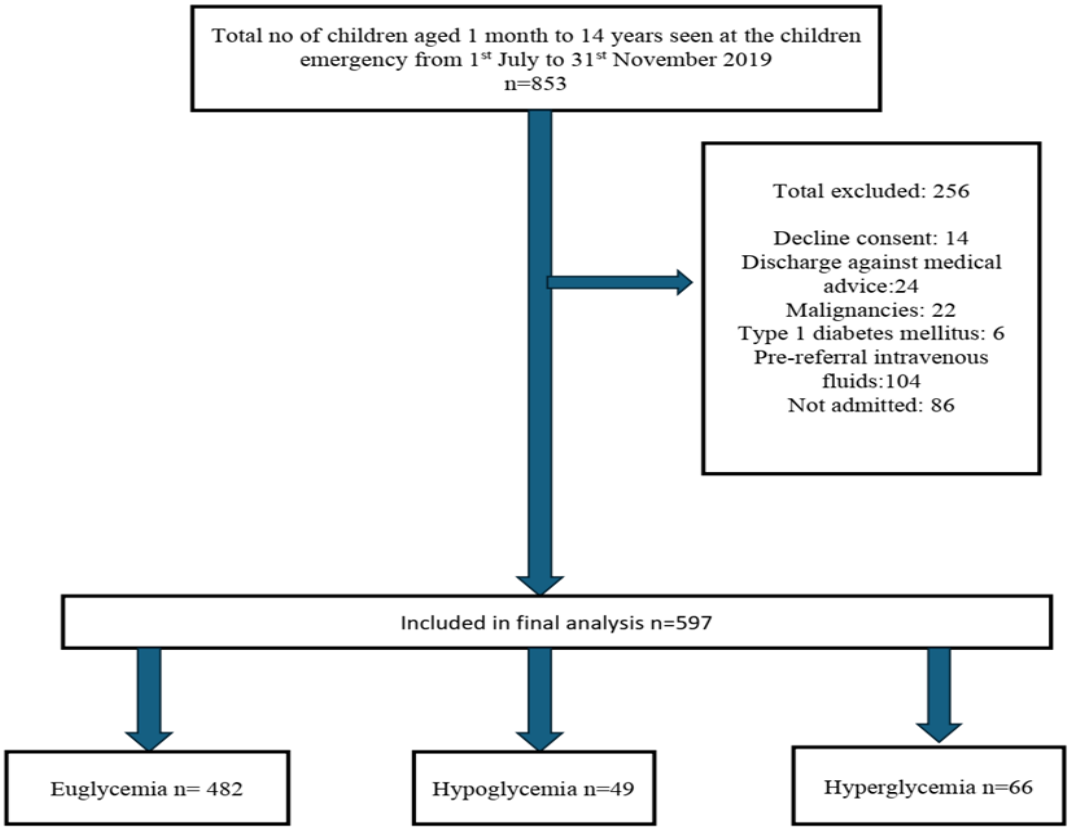


Figure 1: Flow diagram of the recruited study children.

Table 1: General characteristics of the study population

| Variable | Categories | Frequency n= 597 | Percent |
|---|---|---|---|
| **Age median (IQR) years** | 3.5 (1.3-8.0) | | |
| **Age group** | 1 to12 months | 137 | 22.9 |
| | 13 to 59 months | 200 | 33.5 |
| | ≤ 60 months | 260 | 43.6 |
| **Sex** | Male | 328 | 54.9 |
| | Female | 269 | 45.1 |
| **Mothers' education** | No formal education | 458 | 76.7 |
| | Primary | 50 | 8.4 |
| | Secondary | 53 | 8.9 |
| | Tertiary | 36 | 6.0 |
| **Fathers' education** | No formal education | 234 | 39.2 |
| | Primary | 152 | 25.4 |
| | Secondary | 108 | 18.1 |
| | Tertiary | 103 | 17.3 |
| **Mothers' occupation** | Group 1 | 19 | 3.2 |
| | Group 2 | 149 | 25.0 |
| | Group 3 | 429 | 71.8 |
| **Fathers' occupation** | Group 1 | 138 | 23.1 |
| | Group 2 | 440 | 73.7 |
| | Group 3 | 19 | 3.2 |
| **Socio-economic class** | Upper | 47 | 7.9 |
| | Middle | 74 | 12.4 |
| | Lower | 476 | 79.7 |

Occupation groups: Group 1 (Gainfully employed), Group 2 (Partially employed), Group 3 (Unemployed)

The median (interquartile range) age was 3.5 (1.3 to 8) years, a minimum age of 1 month, and a maximum age of 14 years. Most of the children were under 5 (337; 56.4%) and males (328; 54.9%), with a male-to-female ratio of 1.2:1. Most of the mothers had no education 76.7% (458) and were unemployed 71.8% (429). Most of the fathers had at least a primary level of education, 60.8% (363), and were employed, as shown in Table 1.

### *Blood glucose levels among the study children*

The median with interquartile range (IQR) of the random blood glucose at presentation in the studied children was 5.1 (4.0-6.7). The prevalence of hypoglycemia was 8.2% (49/597), with a 99% confidence interval of 6.3 to 10.7%.

### *Relationship between blood glucose levels and diseases among children*

Table 2 shows that hypoglycemia was associated with various diagnoses among the studied children. In addition, based on the various diseases group, highest prevalence of hypoglycemia occurred in those with gastro-intestinal related diseases (33.3%), severe acute malnutrition (39.0%), endocrine diseases (33.3%) and sepsis (13.8%). In contrast, those with cardiovascular system related diseases, and acute poisoning had no hypoglycemia at presentation.

### *Relationship between Socio-demographic determinants and hypoglycemia*

Table 2: Relationship between glucose levels and diseases among the population

| Diagnosis | Total (n=597) | Hypoglycemia n =49 (%)* | Euglycemia n=482 | Hyperglycemia n=66 | G test | P value |
|---|---|---|---|---|---|---|
| **Malaria** | 154 | 11 (7.1) | 118 | 25 | 124.271 | **<0.001** |
| **Respiratory diseases** | 106 | 2 (1.9) | 102 | 2 | | |
| **Sepsis** | 80 | 11 (13.8) | 58 | 11 | | |
| **SCD with complications** | 62 | 1 (1.6) | 57 | 4 | | |
| **Renal diseases** | 45 | 1 (2.2) | 41 | 3 | | |
| **SAM and FTT** | 41 | 16 (39.0) | 25 | 0 | | |
| **CNS diseases** | 35 | 1 (2.9) | 20 | 14 | | |
| **Surgical diseases** | 21 | 1 (4.8) | 20 | 0 | | |
| **Vaccine-preventable diseases** | 11 | 1 (9.1) | 10 | 0 | | |
| **Tuberculosis** | 7 | 1 (14.3) | 6 | 0 | | |
| **CVS disease** | 7 | 0 (0.0) | 6 | 1 | | |
| **GIT diseases** | 6 | 2 (33.3) | 3 | 1 | | |
| **Endocrine diseases** | 3 | 1 (33.3) | 2 | 0 | | |
| **Poisoning** | 5 | 0 (0.0) | 5 | 0 | | |
| **Others** | 14 | 0 (0.0) | 9 | 5 | | |

G test- Likelihood Ratio Chi-Square; SCA-sickle cell anemia), , SAM-severe acute malnutrition, FTT-failure to thrive, CNS-Central nervous system; CVS-Cardiovascular disease, GIT-Gastrointestinal tract.*Prevalence of hypoglycemia (percent) in the disease categories

Based on the age groups, children aged 13 to 59 months had the highest prevalence of hypoglycemia (11.0%), with an odds ratio of 2.4 (95% confidence interval of 1.149 to 4.813).

Also, a higher prevalence of hypoglycemia (9.1%) was obtained among males compared with females (7.1%), though not statistically significant. Based on the duration of illnesses before admission, the highest prevalence of hypoglycemia (9.8%) occurred among the studied children who presented after 48 hours. Also, Table 3 shows that gender, parents' occupations, parents' education levels, and socio-economic classes were comparable among children with and without hypoglycemia at presentation.

### *Outcomes of the study children*

Out of 597 recruited children, 30 deaths occurred (5.0%). Among those with hypoglycemia (n = 49), 8 deaths occurred, with a mortality rate of 16.3%. There were significant differences in mortality between those with hypoglycemia and those with euglycemia, $p<0.001$. The presence of hypoglycemia increased the odds of deaths by 4.5 (95% CI 1.870 to 10.866), as shown in Table 4.

## Discussion

Social determinants of health play a significant role in shaping children's health and outcomes by influencing access to healthcare, health knowledge and practices, socio-economic status, and healthcare utilization patterns (8,9). Our study shows a prevalence of hypoglycemia (8.2%) with a degree of uncertainty that ranges from 6.3 to 10.7% among the study children admitted to the pediatric emergency ward. The relatively large degree of uncertainty obtained in this study indicates the true values could be as low as 6.3% and as high as 10.7%. The prevalence of hypoglycemia value obtained in this study is within the observed prevalence of 6.3% to 22.1% in Nigerian studies (15,18). However, the prevalence of hypoglycemia obtained in this study is higher than 4.2% in Madagascar(19), 3.2% in Mozambique(20), and 7.3% in Kenya(21).

Table 3: Relationship between Socio-determinants of health and hypoglycemia.

| Variable | Total n =597 | Hypo. n=49 | Prev. (%) | OR** | 95% CI | P value |
|---|---|---|---|---|---|---|
| **Age categories** | | | | | | |
| 12 and below | 137 | 14 | 10.2 | 2.0 | 0.919, 4.447 | 0.080 |
| 13-59 months | 200 | 22 | 11.0 | 2.4 | 1.149, 4.813 | **0.019** |
| 60 and more | 260 | 13 | 5.0 | 1 | | |
| **Gender** | | | | | | |
| Male | 328 | 30 | 9.1 | 1.4 | 0.757, 2.524 | 0.292 |
| Female | 269 | 19 | 7.1 | 1 | | |
| **Mothers' Education** | | | | | | |
| No formal | 458 | 38 | 8.3 | 1.8 | 0.409, 7.657 | 0.445 |
| Primary | 50 | 4 | 8.0 | 1.7 | 0.300, 10.120 | 0.536 |
| Secondary | 43 | 5 | 9.4 | 1.9 | 0.353, 10.573 | 0.448 |
| Tertiary | 36 | 2 | 5.6 | 1 | | |
| **Father's Education** | | | | | | |
| No formal | 234 | 17 | 7.3 | 1.0 | 0.405, 2.538 | 0.976 |
| Primary | 152 | 14 | 9.2 | 1.3 | 0.486, 3.244 | 0.938 |
| Secondary | 108 | 11 | 10.2 | 1.6 | 0.602, 4.424 | 0.336 |
| Tertiary | 103 | 7 | 6.8 | 1 | | |
| **Mothers' occupation** | | | | | | |
| Group 1 | 19 | 1 | 5.3 | 1 | | |
| Group 2 | 149 | 12 | 8.1 | 2.1 | 0.257, 17.135 | 0.490 |
| Group 3 | 429 | 36 | 8.4 | 1.8 | 0.233, 13.841 | 0.575 |
| **Father's Occupation** | | | | | | |
| Group 1 | 126 | 12 | 8.7 | 1 | | |
| Group 2 | 440 | 36 | 8.2 | 0.9 | 0.448, 1.772 | 0.742 |
| Group 3 | 19 | 1 | 5.3 | 1.5 | 0.168, 13.654 | 0.712 |
| **SEC#** | | | | | | |
| Upper | 47 | 2 | 4.3 | 1 | | |
| Middle | 74 | 6 | 8.1 | 2.3 | 0.436, 11.931 | 0.329 |
| Lower | 476 | 41 | 8.6 | 2.0 | 0.460, 8.495 | 0.359 |
| **Duration before admission** | | | | | | |
| 24 hours | 134 | 8 | 6.0 | 1 | | |
| 25 to 48 hours | 84 | 4 | 4.8 | 0.7 | 0.215, 2.547 | 0.633 |
| >48 hours | 379 | 37 | 9.8 | 1.7 | 0.749, 3.676 | 0.212 |

Hypo-Hypoglycemia; Prev-prevalence of hypoglycemia. Occupation groups: Group 1 (Gainfully employed), Group 2 (Partially employed), Group 3 (Unemployed); SEC-Socio-economic class; #Oyedeji socio-economic classification.**Vs Euglycemia

The variation in prevalence obtained in this study compared with the other studies may be partly attributed to a lack of consensus in defining hypoglycemia in children. For instance, whereas we used a cut-off of 2.8 mmol/L to define hypoglycemia, the Nigerian study(18) that reported 6.3% used 2.5 mmol/L, the studies in Madagascar(19) and Kenya(21) used 2.2 mmol/l while a cut-off of 3.0 mmol/l in the study in Mozambique. While our study, like others, confirmed a significant number of acutely sick children had hypoglycemia and supported the need to sustain routine blood sugar checks among them. The variation in the cut-off brings some limitations to data comparison and calls for the adoption of a uniform cut-off for easy identification and treatment of hypoglycemia among children.

Table 4: Outcomes of study children with hypoglycemia

| Variables | Total n=531 | Discharge | Death | Odds ratio | 95% confidence interval | p |
|---|---|---|---|---|---|---|
| **Euglycemia** | 482 | 462 (95.6) | 20 (4.1%) | | | |
| **Hypoglycemia** | 49 | 41 (83.7) | 8 (16.3) | 4.507 | 1.870, 10.866 | <0.001 |

This study also shows that young children aged 13 to 59 months were associated with the occurrence of hypoglycemia with an odds ratio of 2.4 compared with those aged 60 months and above. Similar studies in southeastern Nigeria and Madagascar also observed an association between age and hypoglycemia (19,22). In contrast, some Nigerian studies(1,15,18,23) did not find any relationship between age and the occurrence of hypoglycemia. The observation of hypoglycemia in the younger age group may be partly related to the limited capacity for gluconeogenesis in the age group to mobilize glucose, especially during acute illnesses, besides the associated reduced intake. This finding of hypoglycemia in the younger age group affirms the need to prioritize this age group in resource-limited settings.

Children of low socio-economic status have a heightened vulnerability to adverse health outcomes and barriers to accessing adequate healthcare services, which may contribute to disparities in health outcomes (14). However, our study did not demonstrate a significant relationship between parents' education, employment status, socio-economic status, and hypoglycemia in the study children, which is similar to some Nigerian studies (18,22). In contrast to our findings, a study in Madagascar(19) found that hypoglycemia occurred more among the children from the poorest with lower maternal education.

Based on the disease spectrum and occurrence of hypoglycemia, the gastrointestinal diseases, severe acute malnutrition and failure to thrive had highest prevalence of hypoglycemia. This finding agrees with other researchers who have documented gastrointestinal diseases as the commonest causes of hypoglycemia in hospitalized children (7,23). Other causes of hypoglycemia in our study were malnutrition, sepsis, and severe malaria, which are in keeping with other reports from previous studies (6,21). The observation of hypoglycemia in many childhood acute illnesses has been attributed to increased utilization due to ongoing pathology, impaired gluconeogenesis, endotoxins-mediated insulin release, and reduced intake (24,25). Thus, there is a need for close monitoring of the blood sugar of a sick child to avert potential hypoglycemia.

The case fatality rate for hypoglycemia in this study was 16.3%, which is higher compared with children with normoglycemia (4.1%). However, this value is lower than 28.5–41.2% reported in some Nigerian studies,(6,15) 20.0% in Madagascar(19), and 31.8% malnourished children in Kenya (21). The low rate of mortality observed in this study may be because this is a prospective study with protocols that involved prompt treatment of all cases of hypoglycemia. In addition, our hospital policy included attending to all sick children without requesting payment immediately at presentation. Thus, all identified cases were promptly treated without recourse to payment, as bills were settled later. Despite being low compared with other studies, the odds ratio of 4.5 for

deaths among hypoglycemia children illustrated the high case fatality associated with hypoglycemia among the children and calls for the need for close monitoring even after the hypoglycemia has been corrected.

**Limitations**

While our study is a descriptive cross-sectional study with a minimum sample estimated at a 99% confidence level to obtain a larger sample size, we have some limitations. Firstly, children with hypoglycemia were not followed up after discharge. Secondly, most of the recruited children (476; 79.7%) were from low socio-economic classes, which may have impacted our findings. Finally, this is a tertiary health center that manages mostly referred cases and, thus, may not be representative of what happens at the community level.

***Conclusion***

In conclusion, this study shows that among the social determinants of health evaluated in this study, the younger age group (13 to 59 months) was associated with hypoglycemia, and the presence of hypoglycemia increased the odds of death by 4.5. We recommend that in resource-limited settings, younger children, especially under-fives, be prioritized for blood checks when they are acutely ill, and those with confirmed hypoglycemia should also be closely monitored.

***Acknowledgment***

We thank the staff of the Pediatrics, parents and caregivers of the recruited children in this study for their support.

***Authors' contribution***

ORI conceptualized the work, study design, literature review, data gathering, data analysis, draft and revised the manuscript.

AMI- data gathering, data analysis, literature review, draft and review of the manuscript.

JFA- data gathering and visualization, literature review, draft and review of the manuscript.

TBF-data gathering and visualization, literature review, draft and review of the manuscript.

***Ethical considerations***

We conducted this study in accordance with the declaration of Helsinki and informed consent was obtained from the parents and caregivers of the recruited children.

***Funding***

This research work was self-sponsored with no external grant or support.

***Conflicts of interest***

None to be declared

**References:**

1. Elusiyan J, Oyenusi E. Hypoglycaemia in children: Review of the literature. Niger J Paediatr. 2016;43(2):70.

2. Casertano A, Rossi A, Fecarotta S, Rosanio FM, Moracas C, Di Candia F, et al. An Overview of Hypoglycemia in Children Including a Comprehensive Practical Diagnostic Flowchart for Clinical Use. Front Endocrinol (Lausanne) [Internet]. 2021 Aug 2;12(August):1–16. Available from: https://www.frontiersin.org/articles/10.3389/fendo.2021.684011/full

3. Cryer PE. Hypoglycemia, functional brain failure, and brain death. J Clin Invest [Internet]. 2007 Apr 2;117(4):868–70. Available from: http://www.jci.org/cgi/doi/10.1172/JCI31669

4. Sharma A, Davis A, Shekhawat PS. Hypoglycemia in the preterm neonate: etiopathogenesis, diagnosis, management and long-term outcomes. Transl Pediatr [Internet]. 2017 Oct;6(4):335–48. Available from: http://tp.amegroups.com/article/view/16974/17488

5. Zijlmans WCWR, van Kempen AAMW, Serlie MJ, Sauerwein HP. Glucose metabolism in children: influence of age, fasting, and infectious diseases. Metabolism [Internet]. 2009 Sep;58(9):1356–65. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0026049509001619

6. Elusiyan JBE, Adejuyigbe EA, Adeodu O. Hypoglycaemia in a Nigerian Paediatric Emergency Ward. J Trop Pediatr [Internet]. 2005 Nov

16;52(2):96–102. Available from: https://academic.oup.com/tropej/article-lookup/doi/10.1093/tropej/fmi068

7. Papini L, Piga S, Dionisi-Vici C, Parisi P, Ciofi degli Atti ML, Marcias M, et al. Hypoglycemia in a Pediatric Emergency Department. Pediatr Emerg Care [Internet]. 2022 Jan;38(1):e404–9. Available from: https://journals.lww.com/10.1097/PEC.0000000000002305

8. Braveman P, Gottlieb L. The social determinants of health: It's time to consider the causes of the causes. Public Health Rep [Internet]. 2014 Jan 1;129(SUPPL. 2):19–31. Available from: http://journals.sagepub.com/doi/10.1177/00333549141291S206

9. WHO/PAHO. Social Determinants of Health - PAHO/WHO [Internet]. 2024 [cited 2024 Feb 15]. Available from: https://www.paho.org/en/topics/social-determinants-health

10. Ogugua CF, Chikani UN, Okiche CY, Ibekwe UM. Sociodemographic determinants of glycaemic control among children with type 1 diabetes in South Eastern Nigeria. Pan Afr Med J [Internet]. 2021;38(250). Available from: https://www.panafrican-med-journal.com/content/article/38/250/full

11. Mönkemöller K, Müller-Godeffroy E, Lilienthal E, Heidtmann B, Becker M, Feldhahn L, et al. The association between socio-economic status and diabetes care and outcome in children with diabetes type 1 in Germany: The DIAS study (diabetes and social disparities). Pediatr Diabetes [Internet]. 2019 May 14;20:637–44. Available from: https://onlinelibrary.wiley.com/doi/10.1111/pedi.12847

12. Morone JF, Cronholm PF, Teitelman AM, Hawkes CP, Lipman TH. Underrepresented Voices: Impacts of Social Determinants of Health on Type 1 Diabetes Family Management in Single-Parent, Black Families. Can J Diabetes [Internet]. 2022 Aug;46(6):602-610.e1. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1499267122001368

13. Atashbahar O, Sari AA, Takian A, Olyaeemanesh A, Mohamadi E, Barakati SH. The impact of social determinants of health on early childhood development: a qualitative context analysis in Iran. BMC Public Health [Internet]. 2022 Dec 8;22(1):1149. Available from: https://doi.org/10.1186/s12889-022-13571-5

14. Xiao Y, Mann JJ, Chow JCC, Brown TT, Snowden LR, Yip PSF, et al. Patterns of Social Determinants of Health and Child Mental Health, Cognition, and Physical Health. JAMA Pediatr [Internet]. 2023 Dec 1;177(12):1294. Available from: https://jamanetwork.com/journals/jamapediatrics/fullarticle/2810494

15. Musa A, Ilah B, Sakajiki A, Adeniji A, Yusuf I. Prevalence and outcome of hypoglycemia in children attending emergency pediatric unit of a specialist hospital in Nigeria. Sahel Med J. 2019 Apr;22(2):77–81.

16. Sperling M. Hypoglycemia. In: Kliengman R, Berhman R, Jenson H, editors. Nelson Textbook of Pediatrics. 17th ed. Philadelphia: Saunder, Elsevia Inc; 2003. p. 505–17.

17. Oyedeji GA. Socio economic and Cultural Background of Hospitalized Children in Ilesha. Niger J Paediatr. 1985;12(4):111–7.

18. Bulus SG, Olateju KE, Offiong UM. Prevalence of Hypoglycaemia in Children admitted into the Emergency Paediatric Unit of University of Abuja Teaching Hospital Gwagwalada , Nigeria. World J Innov Res. 2020;8(2):89–94.

19. Barennes H, Sayavong E, Pussard E. High Mortality Risk in Hypoglycemic and Dysglycemic Children Admitted at a Referral Hospital in a Non Malaria Tropical Setting of a Low Income Country. Folli F, editor. PLoS One [Internet]. 2016 Feb 24;11(2):e0150076. Available from: http://dx.doi.org/10.1371/journal.pone.0150076

20. Lola M, Sozinho A, Tacilta N, Miguel L, Antonio S, Sonia AM, et al. Hypoglycemia and Risk Factors for Death in 13 Years of Pediatric Admissions in Mozambique. Am J Trop Med Hyg [Internet]. 2016 Jan 6;94(1):218–26. Available from: https://ajtmh.org/doi/10.4269/ajtmh.15-0475

21. Osier FHA, Berkley JA, Ross A, Sanderson F, Mohammed S, Newton CRJC. Abnormal blood glucose concentrations on admission to a rural Kenyan district hospital: Prevalence and outcome. Arch Dis Child. 2003;88(7):621–5.

22. Azuka NC, Chukwuka JO, Ebenebe JC, Ofiaeli OC. Hypoglycaemia in children aged 1 month to 17 years admitted to the children's emergency room of nnamdi azikiwe university teaching hospital, nnewi, nigeria. SAJCH South African J Child Heal. 2021;15(1):25–32.

23. Oyenusi EE, Oduwole AO, Oladipo OO, Njokanma OF, Esezobor CI. Hypoglycaemia in children aged 1 month to 10 years admitted to the Children's Emergency Centre of Lagos University Teaching Hospital, Nigeria. South African J Child Heal [Internet]. 2014 Aug 15;8(3):107. Available from: http://www.sajch.org.za/index.php/sajch/article/view/1599

24.Filkins J, Cornell R. Depression of hepatic gluconeogenesis and the hypoglycemia of endotoxin shock. Am J Physiol Content [Internet]. 1974 Oct 1;227(4):778–81. Available from: https://www.physiology.org/doi/10.1152/ajplegacy.1974.227.4.778

25.Yelich MR, Filkins JP. Mechanism of hyperinsulinemia in endotoxicosis. Am J Physiol Metab [Internet]. 1980 Aug 1;239(2):E156–61. Available from: https://www.physiology.org/doi/10.1152/ajpendo.1980.239.2.E156