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### Book:

Park K. *Park's Textbook of Preventive and Social Medicine*. 20<sup>th</sup> ed. Jabalpur, India: M/s Barnasidas Bhanot; 2009.

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## From the Editor-in-Chief

It is with great pleasure that I present **Volume 6, Issue 1 (December 2025)** of the **International Archives of Medical and Health Research (IAMHR)**, an issue that reflects the evolving landscape of health research in low- and middle-income settings while advancing globally relevant scientific discourse.

This edition brings together a rich collection of empirical studies and narrative reviews addressing critical dimensions of public health, clinical medicine, health systems strengthening, and emerging biomedical science. Collectively, the contributions underscore a shared commitment to improving health outcomes through evidence-based practice, contextualized research, and multidisciplinary collaboration.

Several articles in this issue illuminate persistent public health challenges affecting vulnerable populations. Studies examining predictors of childhood immunization status and awareness of health facility delivery among women highlight ongoing efforts to strengthen maternal and child health services and reduce preventable morbidity and mortality. Complementing these are investigations into tuberculosis-HIV coinfection and treatment adherence, as well as research on health insurance readiness among civil servants, both of which provide valuable insights into strategies to improve access to care and minimize catastrophic out-of-pocket health expenditures.

Occupational and patient safety also receive important attention. Research exploring occupational health knowledge and safety practices among automobile mechanics emphasizes the need for stronger workplace health protection, while an examination of physicians' perceptions of medical error reporting offers timely insights into building safer, more accountable healthcare systems.

From a clinical and biomedical perspective, this issue advances understanding of

disease mechanisms and diagnostic challenges. The study on serum Vitamin A levels in children with cerebral malaria contributes to ongoing efforts to improve outcomes in severe pediatric infections. Equally compelling are the narrative reviews on mirror movements and paroxysmal dyskinesias in children, conditions that remain under-recognized and frequently misdiagnosed in resource-limited settings, highlighting the critical role of clinical awareness in improving pediatric neurological care.

Expanding beyond traditional clinical research, an innovative experimental investigation utilizing *Drosophila melanogaster* explores the synergistic effects of combined high-fat and high-sugar diets, offering mechanistic insights into metabolic and behavioral dysfunction that resonate with the growing global burden of non-communicable diseases. Together, the articles featured in this issue demonstrate the power of locally grounded research to address universal health challenges. They reflect the dedication of researchers working across diverse contexts to generate knowledge that informs policy, strengthens healthcare delivery, and ultimately improves population health.

On behalf of the Editorial Board, I extend sincere appreciation to our authors, reviewers, and readers whose scholarly contributions sustain the vision and integrity of IAMHR. As we continue to promote rigorous multidisciplinary health research, we remain committed to fostering scientific excellence, innovation, and the dissemination of impactful knowledge.

We hope that this issue stimulates further research, encourages interdisciplinary dialogue, and contributes meaningfully to the advancement of health systems and clinical practice across Africa and beyond.

**Prof. Igoche George Ameh**  
Editor-in-Chief, IAMHR



# Predictors of Immunization Status Among Children Aged 12-59 Months in Rural and Urban Communities of Sokoto State, Nigeria

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## ABSTRACT

**Background:** Immunization remains a key part of child health in Nigeria, but coverage gaps persist in the Northern regions, leading to outbreaks of vaccine-preventable diseases such as measles, meningitis, and diphtheria. **Aim:** This study aims to identify and compare predictors of immunization status among children under five in rural and urban communities of Sokoto State, Nigeria. **Materials and Methods:** A comparative cross-sectional study was conducted in Sokoto State, Nigeria, among 260 mother-child pairs (130 in urban and 130 in rural areas). The participants were selected by a multi-stage sampling technique. Data were collected using an interviewer-administered questionnaire and a checklist. Data were processed using IBM® SPSS version 25 and analysed using descriptive and inferential statistics. **Results:** Only 31.5% and 20.0% of the children in urban and rural areas, respectively, were fully immunized ( $p=0.001$ ). Formal education of the mothers ( $aOR=3.54$ ; 95%CI= 1.01– 10.25), social class ( $aOR=3.98$ ; 95%CI= 0.11 – 0.59), maternal TT vaccination ( $aOR=0.099$ ; 95%CI= 0.04 – 0.24), and postnatal care ( $aOR=3.66$ ; 95%CI= 1.25 – 10.67) predicted immunization status in the urban group. In the rural group, formal education of the mothers ( $aOR=8.62$ ; 95%CI= 1.76 – 16.31) and occupation of the father ( $aOR=0.15$ ; 95%CI= 0.33 – 0.66) were the predictors of the immunization status of the children. **Conclusion:** Full immunization coverage was suboptimal in both rural and urban communities, though higher in urban areas. Maternal education and immunization card retention were consistent predictors, while socioeconomic status and maternal health service utilization were particularly influential in urban settings. Strengthening female education, maternal health service engagement, record retention, and targeted rural strategies is essential to improve coverage and reduce disparities.

**Keywords:** Childhood Immunization, Immunization status, under-five children. Predictors, Northern Nigeria

## INTRODUCTION

Despite substantial global progress in routine immunization, vaccine-preventable diseases remain a major contributor to under-five morbidity and mortality in low- and middle-income countries. In Nigeria, vaccine-preventable deaths account for a considerable proportion of under-five mortality,<sup>1</sup> reflecting persistent gaps in routine immunization performance. Immunization remains one of the most cost-effective public health interventions for preventing life-threatening infectious diseases and reducing childhood mortality.<sup>2-4</sup> However, Nigeria continues to bear a high burden of incompletely vaccinated children in sub-Saharan Africa.<sup>5</sup>

National data indicate persistently low and inequitable immunization coverage. According to the Multiple Indicator Cluster Survey/National Immunization

Coverage Survey (MICS/NICS) 2021, only 35.6% of children received all three doses of the pentavalent vaccine, with marked regional disparities.<sup>6</sup> Coverage is consistently lower in the northern geopolitical zones, particularly the North-West, compared to southern regions.<sup>6</sup> Sokoto State has recorded some of the lowest immunization indicators nationally, with only 2.2% of children aged 12–23 months reported to be fully vaccinated in previous surveys.<sup>6</sup>

The Nigeria Demographic and Health Survey (NDHS) 2024 further highlights disparities by place of residence, showing that 47.7% of children aged 12–23 months were fully vaccinated in urban areas compared to 33.8% in rural areas.<sup>7</sup> These patterns mirror broader inequities in child survival, with higher under-five mortality rates reported in northern Nigeria.<sup>6</sup>

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Evidence from Nigeria and other sub-Saharan African countries demonstrates that immunization uptake is shaped by a complex interplay of socio-demographic, economic, and health system factors. Maternal education, household wealth, religion, geographic location, and health service access have consistently been associated with full immunization status.<sup>8–10</sup> Children residing in urban areas generally exhibit higher immunization coverage than their rural counterparts, reflecting differences in service availability, caregiver awareness, and socioeconomic conditions.<sup>9,10</sup> While several studies have examined determinants of immunization in Nigeria, limited research has simultaneously compared predictors across rural and urban communities within the same Northern Nigerian setting.

Understanding whether predictors operate similarly or differently across residence contexts is critical for designing context-sensitive interventions to reduce inequities and improve overall coverage.<sup>11</sup> Given the persistently low immunization coverage in Sokoto State and the documented rural–urban disparities in northern Nigeria, there is a need for context-specific evidence to inform targeted public health strategies. This study aims to identify and compare predictors of immunization status among children under five in rural and urban communities of Sokoto State, Nigeria.

## MATERIALS AND METHODS

### Study Design, Population, and Area

This study employed a comparative cross-sectional design. The study population comprised mothers or caregivers with children aged 12 to 59 months in urban and rural communities of Sokoto State. All those who gave consent to participate in the study were considered eligible and enrolled.

### Sample Size Estimation and Sampling Technique

The sample size was estimated at 130 mother-child pairs per group using the formula for comparing proportions in two independent samples<sup>12</sup>, based on the 26% and 44% basic vaccination coverage in rural and urban areas, respectively, obtained in the Nigerian Demographic and Health Survey 2018<sup>7</sup>, and an anticipated 90% response rate.<sup>19</sup> A multistage sampling technique was used to select respondents for the study. In stage 1, Sokoto North LGA

(urban) and Wurno LGA (rural) were selected among the urban and rural LGAs in Sokoto State using a simple random sampling technique by balloting. In stage 2, two wards were selected from each of the selected LGAs by a simple random sampling technique (balloting). In stage 3, one settlement was chosen from each of the four wards by a simple random sampling technique (balloting). Proportionate allocation (PA) of respondents to be enrolled in each settlement within each group (urban and rural) was done based on the calculated sample size per group, which was 130 per group. In stage 4, a sampling frame was obtained from the Sokoto State World Health Organization office, and systematic random sampling was used to select households for the study. In a selected household with more than one eligible mother-child pair, one of them is selected by simple random sampling using the balloting option. If the occupants of a selected household are absent, the next household is selected.

### Data Collection

The socio-demographic data and other information were collected from the mothers/caregivers of all the children enrolled in the study by interview method (using an interviewer-administered questionnaire) and recorded on a structured questionnaire. The questionnaire was reviewed by senior researchers in the Department of Community Medicine at Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria, to assess content validity. The information included the child's biodata, antenatal care, postnatal care, and delivery history, immunization history, nutritional history, and family and social history. Each child was assigned to a socioeconomic class using Oyedepi's method, based on parents' occupations and levels of education.<sup>13</sup>

Information about child immunizations was collected from immunization cards and the mother's verbal report, with the verification of the presence of a BCG scar. Mothers or caregivers were asked to show the children's health record cards, which contained individual immunization data. Where the card was available, the interviewer extracted immunization information and entered it into the checklist appropriately. Where there was no specific information on the card, the mother or caregiver was then asked to confirm or otherwise whether the child had received other vaccinations that were not recorded on the card. If there was no immunization card

or the mother or caregiver was unable to present it, the child's immunization information was based on the child's recall. In case of immunization failure, they were asked to give reasons for the failure.

### Data Analysis

Data were analyzed using IBM SPSS version 25. Quantitative variable (Age) was summarized using the mean and standard deviation, and categorical variables (sociodemographic and immunization status) were summarized using frequencies and percentages. The results were presented in tables and charts. Where the assumptions for Pearson's Chi-square test were violated, Fisher's Exact Test ( $r \times c$  extension) was used to assess associations between categorical variables. Factors found to be statistically significant in the bivariate analysis were included in a binary logistic regression model to identify predictors of immunization status. The regression analyses were presented in tables with adjusted Odds Ratios (aORs), confidence intervals (CIs), and their  $p$ -values. All levels of significance ( $\alpha$ ) were set at  $p < 0.05$ .

### Ethical Consideration

Institutional ethical approval for the study was obtained from the Research and Ethics Committee of the Ministry of Health, Sokoto, Nigeria. Permission for community entry was also obtained from the State Ministry of Local Government Affairs, the LGA chairmen, and the district heads of the communities before proceeding with the study. The purpose of the study was explained to the participants, and they were assured that their information would be kept confidential. A consent form was given to the literate respondents to read and sign, and was read out in the native Hausa language to the respondents with no formal education to thumbprint.

## RESULTS

### Sociodemographic characteristics of respondents

About one third of mothers in the urban group 45 (34.6%), compared to 3 (2.3%) in the rural group, had completed their secondary education, while 109 (83.8%) had only Quranic education in the rural group, compared to 58 (44.6%) in the urban group. The rural group had a higher proportion of unemployed mothers, 80 (61.5%), compared to the urban group, 48 (36.9%). There was a statistically significant difference in the educational

attainment and occupation of the mothers of the children in both groups ( $p < 0.001$ ). There was a statistically significant difference ( $p < 0.001$ ) in the distribution of respondents by social class, with the majority in social classes IV and V in the urban (48.5%) and rural (49.2%) groups, respectively [Table 1].

### Demographic characteristics of children, place of delivery, and birth order

The highest proportion of children in both the urban 38 (29.2%) and rural 42 (32.3%) groups was in the age group 48-59 months. There was no statistically significant difference in age ( $\chi^2 = 0.927$ ,  $p = 0.467$ ). The mean ages in the urban and rural areas were  $34.70 \pm 14.4$  and  $35.12 \pm 14.8$  months, respectively ( $t = 0.233$ ,  $p = 0.816$ ). There was no statistically significant difference in the gender distribution in the groups ( $\chi^2 = 0.988$ ,  $p = 0.384$ ). A higher proportion of children in the rural group 106 (81.5%) were delivered at home compared to 69 (53.1%) in the urban group; and this was statistically significant (Fisher's exact,  $p < 0.001$ ) [Table 2].

### Maternal health care utilization by the mothers

The majority of the mothers in the two groups (urban: 91.5%; rural: 91.5%) attended antenatal care ( $p = 1.000$ ). Similarly, almost half of the mothers in both groups (urban: 49.2%; rural: 48.5%) attended postnatal care ( $p = 1.000$ ). In urban areas, 97 (74.6%) received TT immunization, compared with 105 (80.8%) in rural areas ( $\chi^2 = 1.420$ ,  $p = 0.297$ ) [Table 3].

### Immunization status of the children by cards and mothers' recall

The immunization coverage by card and mother recall. About a third 41 (31.5%) of the children in the urban group and 26 (20.0%) of the children in the rural group were fully immunized. Similarly, 48 (37.0%) of the children in the urban group, compared with 65 (50.0%) from the rural group, were partially immunized. About a third of the children in both groups were unimmunized: 41 (31.5%) in the urban group and 39 (30.0%) in the rural group. There was a statistically significant difference in the immunization status between the 2 groups. ( $\chi^2 = 5.966$ ,  $p = 0.047$ ) [Table 4].

### Presentation of the child's immunization card by mothers

A higher proportion of children in urban areas (57, 76.0%) than in rural areas (50, 68.5%) have their immunization cards, but this difference was not statistically significant ( $p=0.360$ ) [Figure 1].

### Availability of health facilities and provision of immunization services

A higher proportion of respondents in urban areas (99.2%) than in rural areas (82.8%) reported that immunization services were provided at a convenient place, and this difference was statistically significant ( $p<0.001$ ) [Table 5].

### Predictors of children's immunization status

In urban communities, children whose mothers had formal education were about 3.5 times more likely than those whose mothers had informal education to be fully immunized ( $aOR = 3.54$ ; 95% CI = 1.01–10.25,  $p = 0.047$ ). Children who were in the middle social class were about 6.0 times less likely than those in the upper social class to have complete immunization ( $aOR= 5.92$ ; 95%

CI= 0.05 – 0.54;  $p= 0.003$ ). Those in the lower social class were about 4.0 times less likely to be fully immunized ( $aOR = 3.98$ ; 95% CI = 0.11–0.59;  $p = 0.002$ ). Children whose mothers received three or more doses of the TT vaccine were about 90.1% (10.1 times) less likely than those who received two doses or less to have incomplete immunization ( $aOR= 0.099$ ; 95% CI= 0.04 – 0.24;  $p< 0.001$ ). Children whose mothers attended postnatal care were 3.7 times more likely to be fully immunized ( $aOR= 3.66$ ; 95% CI= 1.25 – 10.67;  $p= 0.017$ ) as compared to those children whose mothers had not attended postnatal care. Children with immunization cards were about 5.2 times more likely to be fully immunized ( $aOR= 5.51$ ; 95% CI= 1.87 – 14.59;  $p= 0.002$ ) than those without immunization cards. In rural communities, children of mothers with formal education were about 8.6 times ( $aOR= 8.62$ ; 95% CI= 1.76 – 16.31;  $p= 0.001$ ) more likely to be fully immunized than those of mothers with informal education. Children of civil servants were about 7.7 times more likely to be fully immunized than children of farmers ( $aOR= 7.71$ ; 95% CI= 1.32 – 45.00;  $p= 0.023$ ). Those with the presence of an immunization card were 9.5 times more likely to be fully immunized ( $aOR= 9.53$ ; 95% CI= 3.29 – 27.96;  $p= 0.001$ ) than those without an immunization card [Table 6].

**Table 1: Sociodemographic characteristics of the respondents**

| Variables                    | Urban (n=130)<br>n (%) | Rural (n=130)<br>n (%) | Test-statistic<br>p-value      |
|------------------------------|------------------------|------------------------|--------------------------------|
| Age group of mothers (years) |                        |                        |                                |
| 15-19                        | 2 (1.5)                | 10 (7.7)               | $\chi^2 = 11.059$<br>p=0.025*  |
| 20 – 24                      | 13 (10.0)              | 22 (16.9)              |                                |
| 25 – 29                      | 63 (48.5)              | 44 (33.8)              |                                |
| 30 – 34                      | 27 (20.8)              | 28 (21.6)              |                                |
| ≥35                          | 25 (19.2)              | 26 (20.0)              |                                |
| Mean ± SD (years)            | 32.99 ± 7.598          | 30.11 ± 8.348          | t=2.914<br>p=0.004*            |
| Religion                     |                        |                        |                                |
| Islam                        | 125 (96.2)             | 130 (100)              | Fischer's exact<br>p=0.029*    |
| Christianity                 | 5 (3.8)                | 0                      |                                |
| Tribe                        |                        |                        |                                |
| Hausa                        | 113 (86.9)             | 108 (83.1)             | Fischer's exact<br>p<0.001*    |
| Fulani                       | 9 (6.9)                | 7 (5.4)                |                                |
| Yoruba                       | 5 (3.8)                | 1 (0.8)                |                                |
| Igbo                         | 3 (2.3)                | 0                      |                                |
| Zabarmawa                    | 0                      | 14 (10.8)              |                                |
| Number of children           |                        |                        |                                |
| 1 – 4                        | 65 (50.0)              | 79 (60.8)              | $\chi^2 = 3.051$<br>p= 0.105   |
| ≥ 5                          | 65 (50.0)              | 51 (39.2)              |                                |
| Mothers' education level     |                        |                        |                                |
| None                         | 2 (1.5)                | 3 (2.3)                | Fischer's exact<br>p<0.001*    |
| Quranic only                 | 58 (44.6)              | 109 (83.8)             |                                |
| Primary                      | 9 (6.9)                | 14 (10.8)              |                                |
| Secondary                    | 45 (34.6)              | 3 (2.3)                |                                |
| Tertiary                     | 16 (12.3)              | 1 (0.8)                |                                |
| Fathers' education level     |                        |                        |                                |
| None                         | 0 (0.0)                | 0                      | Fischer's exact<br>p<0.001*    |
| Quranic only                 | 16 (12.3)              | 60 (46.1)              |                                |
| Primary                      | 2 (1.5)                | 7 (5.4)                |                                |
| Secondary                    | 56 (43.1)              | 46 (35.4)              |                                |
| Tertiary                     | 56 (43.1)              | 17 (13.1)              |                                |
| Occupation of the mother     |                        |                        |                                |
| Unemployed                   | 48 (36.9)              | 80 (61.5)              | Fischer's exact<br>p<0.001*    |
| Farming                      | 0 (00.0)               | 0 (0.0)                |                                |
| Trade/business               | 77 (59.2)              | 48 (36.9)              |                                |
| Civil servant                | 5 (3.9)                | 2 (1.5)                |                                |
| Occupation of father         |                        |                        |                                |
| Unemployed                   | 0 (0.0)                | 0                      | $\chi^2 = 47.070$<br>p< 0.001* |
| Farming                      | 6 (4.6)                | 39 (30.0)              |                                |
| Trade/business               | 66 (50.8)              | 74 (56.9)              |                                |
| Civil servant                | 58 (44.6)              | 17 (13.1)              |                                |
| Social class of the parent   |                        |                        |                                |
| SC I                         | 2 (1.5)                | 0                      | Fischer's exact<br>p<0.001*    |
| SC II                        | 14 (10.8)              | 1 (0.8)                |                                |
| SC III                       | 41 (31.5)              | 7 (5.4)                |                                |
| SC IV                        | 63 (48.5)              | 58 (44.6)              |                                |
| SC V                         | 10 (7.7)               | 64 (49.2)              |                                |

$\chi^2$ -Pearson's Chi-square test; t- Independent t-test; \*Statistically significant p < 0.05

**Table 2: Demographic characteristics of children, place of delivery, and birth order**

| Variables                  | Urban (n=130)<br>n (%) | Rural (n=130)<br>n (%) | Test-statistic<br>p-value    |
|----------------------------|------------------------|------------------------|------------------------------|
| Child's age group (months) |                        |                        |                              |
| 12-23                      | 32 (24.6)              | 28 (21.5)              | $\chi^2 = 0.927$<br>p=0.467  |
| 24-35                      | 30 (23.1)              | 30 (23.1)              |                              |
| 36-47                      | 30 (23.1)              | 30 (23.1)              |                              |
| 48-59                      | 38 (29.2)              | 42 (32.3)              |                              |
| Mean $\pm$ SD (months)     | 34.70 $\pm$ 14.4       | 35.12 $\pm$ 14.8       | t= 0.233,<br>p=0.816         |
| Sex                        |                        |                        |                              |
| Male                       | 57 (43.8)              | 65 (50.0)              | $\chi^2 = 0.988$<br>p=0.384  |
| Female                     | 73 (56.2)              | 65 (50.0)              |                              |
| Place of delivery          |                        |                        |                              |
| Home                       | 69 (53.1)              | 106 (81.5)             | Fischer's exact<br>p<0.001*  |
| Hospital                   | 56 (43.1)              | 24 (18.5)              |                              |
| Clinic/dispensary          | 4 (3.1)                | 0 (0.0)                |                              |
| TBAs house                 | 1 (0.8)                | 0 (0.0)                |                              |
| Birth order                |                        |                        |                              |
| 1- 2                       | 30 (23.0)              | 50 (38.5)              | $\chi^2 = 8.388$<br>p=0.016* |
| 3 – 4                      | 37 (28.5)              | 36 (27.7)              |                              |
| $\geq 5$                   | 63 (48.5)              | 44 (33.8)              |                              |

$\chi^2$ -Pearson's Chi-square test; t- Independent t-test; \*Statistically significant, p < 0.05

**Table 3: Antenatal and postnatal care utilization by the mothers**

| Variables                | Urban (n=130)<br>n (%) | Rural (n=130)<br>n (%) | Test-statistic<br>p-value    |
|--------------------------|------------------------|------------------------|------------------------------|
| Attended ANC             |                        |                        |                              |
| Yes                      | 119 (91.5)             | 119 (91.5)             | $\chi^2 = 0.000$<br>P= 1.000 |
| No                       | 11 (8.5)               | 11 (8.5)               |                              |
| Attended PNC             |                        |                        |                              |
| Yes                      | 64 (49.2)              | 63 (48.5)              | $\chi^2 = 0.015$<br>p=1.000  |
| No                       | 66 (50.8)              | 67 (51.5)              |                              |
| Received TT immunization |                        |                        |                              |
| Yes                      | 97 (74.6)              | 105 (80.8)             | $\chi^2 = 1.420$<br>p= 0.297 |
| No                       | 33 (25.4)              | 25 (19.2)              |                              |

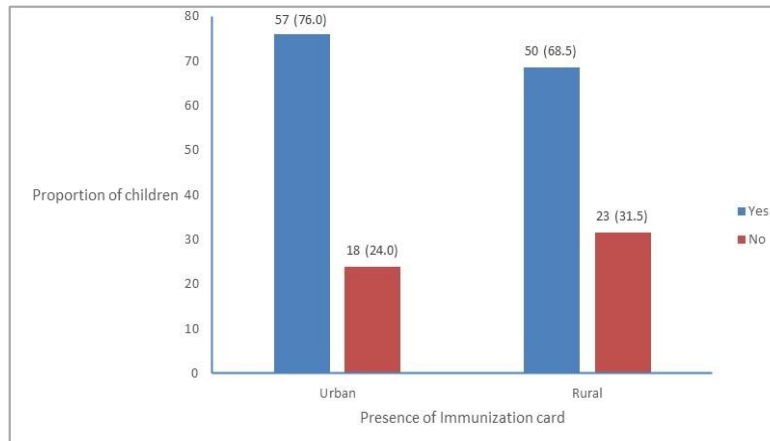
$\chi^2$ -Pearson's Chi-square test ANC=antenatal care PNC=postnatal care TT=Tetanus Toxoid



**Table 4: Immunization status of the children by cards and mothers' recall**

| Vaccine                    | Urban (n=130)<br>n (%) | Rural (n=130)<br>n (%) | Test-statistic<br>$\chi^2$ | p-value |
|----------------------------|------------------------|------------------------|----------------------------|---------|
| BCG                        | 66 (51.2)              | 60 (46.5)              | 0.558                      | 0.455   |
| HBVo                       | 69 (53.1)              | 66 (51.2)              | 0.095                      | 0.804   |
| OPV                        |                        |                        |                            |         |
| 0                          | 78 (60.0)              | 74 (56.9)              | 0.253                      | 0.706   |
| 1                          | 76 (58.5)              | 78 (60.0)              | 0.064                      | 0.900   |
| 2                          | 69 (53.1)              | 72 (55.4)              | 0.139                      | 0.803   |
| 3                          | 61 (46.9)              | 67 (52.3)              | 0.758                      | 0.455   |
| Penta                      |                        |                        |                            |         |
| 1                          | 67 (51.5)              | 57 (44.2)              | 1.403                      | 0.264   |
| 2                          | 58 (44.6)              | 47 (36.4)              | 1.798                      | 0.206   |
| 3                          | 51 (39.2)              | 45 (34.9)              | 0.758                      | 0.455   |
| PCV                        |                        |                        |                            |         |
| 1                          | 65 (50.0)              | 56 (43.1)              | 1.403                      | 0.264   |
| 2                          | 58 (44.6)              | 47 (36.2)              | 1.933                      | 0.164   |
| 3                          | 51 (39.2)              | 44 (34.4)              | 0.654                      | 0.441   |
| IPV                        | 43 (33.1)              | 40 (31.0)              | 0.160                      | 0.790   |
| Measles                    | 54 (41.5)              | 56 (43.1)              | 0.63                       | 0.900   |
| Yellow fever               | 48 (37.2)              | 48 (36.9)              | 0.002                      | 1.000   |
| Men A                      | 41 (32.0)              | 33 (25.8)              | 1.217                      | 0.335   |
| <b>Immunization status</b> |                        |                        |                            |         |
| Fully immunized            | 41 (31.5)              | 26 (20.0)              |                            |         |
| Partially immunized        | 48 (37.0)              | 65 (50.0)              | 5.966                      | 0.047*  |
| Un-immunized               | 41 (31.5)              | 39 (30.0)              |                            |         |

$\chi^2$ -Pearson's Chi-square test; BCG- Bacillus Calmette-Guerin; HBV-hepatitis B vaccine; OPV- oral polio vaccine; PCV- pneumococcal conjugate vaccine; IPV- inactivated polio vaccine; Men A- Meningitis A conjugate vaccine; \*Statistically significant, p < 0.05



**Figure 1: Presentation of the child's immunization card by mothers**

**Table 5: Availability of health facilities and provision of immunization services**

| Variables                                                        | Urban<br>n (%) | Rural<br>n (%) | Test<br>statistic | p- value |
|------------------------------------------------------------------|----------------|----------------|-------------------|----------|
| Availability of health facilities in the locality                | n= 130         | n= 130         |                   |          |
| Yes                                                              | 130 (100)      | 99 (76.2)      | $\chi^2= 32.072$  | <0.001*  |
| No                                                               | 0 (0.0)        | 31 (23.8)      |                   |          |
| Routine immunization service is available in the health facility | n= 130         | n= 99          |                   |          |
| Yes                                                              | 130 (100.0)    | 98 (99.1)      | Fisher's exact    | 0.893    |
| No                                                               | 0 (0.0)        | 1 (0.9)        |                   |          |
| Routine immunization is provided at a convenient place           | n= 130         | n= 130         |                   |          |
| Yes                                                              | 128 (99.2)     | 107 (82.8)     | $\chi^2= 21.067$  | <0.001*  |
| No                                                               | 2 (0.8)        | 23 (17.2)      |                   |          |
| Time taken to reach the health facility                          | n= 127         | n= 99          |                   |          |
| ≤ 30 minutes                                                     | 124 (97.6)     | 90 (90.9)      |                   |          |
| > 30 minutes                                                     | 3 (2.4)        | 9 (9.1)        | $\chi^2= 5.010$   | 0.035*   |

$\chi^2$ - Pearson's Chi-Square test; \*Statistically significant,  $p < 0.05$

**Table 6: Predictors of children's immunization status**

| Variables                                           | Urban        |               |          | Rural         |               |         |
|-----------------------------------------------------|--------------|---------------|----------|---------------|---------------|---------|
|                                                     | aOR          | 95% CI        | p value  | aOR           | 95% CI        | p value |
|                                                     | Lower- Upper |               |          | Lower - Upper |               |         |
| Education of Mother<br>(Formal vs Nonformal*)       | 3.54         | 1.01 – 10.25  | 0.047**  | 8.62          | 1.76 – 16.31  | 0.038** |
| Education of the father<br>(Formal vs Nonformal*)   | 3.517        | 0.36 – 34.81  | 0.282    | 1.087         | 0.02-55.273   | 0.967   |
| Occupation of father<br>(Civil servant vs farmers*) | 3.551        | 1.60 – 7.87   | 0.002**  | 7.71          | 1.32 – 45.00  | 0.023** |
| (Businessmen vs Farmers*)                           | 4.355        | 0.479 – 39.62 | 0.192    | 1.21          | 0.38 – 3.87   | 0.753   |
| Social class<br>(Middle vs Upper*)                  | 0.169        | 0.05 – 0.54   | 0.003**  | 1.642         | 0.189-14.234  | 0.653   |
| (Lower vs upper*)                                   | 0.251        | 0.11 – 0.59   | 0.002**  | 10.483        | 0.136-54.213  | 0.416   |
| Mother attended ANC<br>(Yes vs no*)                 | 3.47         | 0.79 – 2.41   | 0.999    | 0.913         | 0.738-21.246  | 1.00    |
| Mother received TT<br>(≥3doses vs ≤2doses*)         |              | 0.04 – 0.24   | <0.001** | 2.923         | 0.235-34.169  | 0.999   |
| Mother attended PNC<br>(Yes vs no*)                 | 3.66         | 1.25 – 10.67  | 0.017**  | 3.453         | 0.119-100.582 | 0.471   |
| Place of delivery<br>(Hospital vs home*)            | 0.75         | 0.45 – 1.25   | 0.269    | 0.332         | 0.042-2.625   | 0.296   |
| Presence of an immunization<br>card<br>(Yes vs no*) | 5.22         | 1.87 – 14.59  | 0.002**  | 9.53          | 3.29 – 27.96  | 0.001** |

aOR = Adjusted Odds Ratio; CI = Confidence Interval; \* = Reference group; \*\*Statistically significant, p < 0.05

## DISCUSSION

This study identified key determinants of immunization status among children aged 12–59 months in rural and urban communities of Sokoto State, Nigeria. By comparing predictors across residence settings, the study provides subnational evidence on both shared and context-specific drivers of immunization uptake in Northwestern Nigeria. Coverage varied across individual antigens in both urban and rural communities. Early vaccines administered at birth or shortly thereafter (BCG, OPV0, HBV0, and Penta1) recorded the highest uptake

in both settings. The proximity of these vaccines to the time of delivery likely explains the relatively higher coverage, as many children have contact with health services immediately after birth. Similar patterns were reported in a comparative study conducted in Bayelsa State, Nigeria, where OPV0 and OPV1 had the highest coverage in urban and rural areas, respectively.<sup>14</sup> Additionally, the relatively high OPV coverage may reflect supplemental immunization activities conducted during Immunization Plus Days, which could inflate reported uptake.

In contrast, coverage for measles and yellow fever vaccines, administered in late infancy, was considerably lower. This drop-off suggests attrition along the immunization continuum, likely due to missed follow-up visits, waning caregiver motivation, or structural access barriers. Similar findings have been reported in Oyo, Bayelsa, and India.<sup>14,15,16</sup> However, higher coverage rates have been documented in North Central Nigeria and Imo State,<sup>17,18</sup> highlighting regional heterogeneity in immunization performance. The lowest coverage was observed in both urban and rural areas for the Men-A conjugate vaccine. This is consistent with the timing of its integration into Nigeria's routine immunization schedule in August 2019,<sup>19</sup> by which time many children in the study cohort had already completed their primary immunization series. Approximately one-third of children in urban areas were fully immunized compared to one-fifth in rural areas. This urban advantage aligns with findings from the 2024 Nigeria Demographic and Health Survey (NDHS), conducted by the National Population Commission, which reported higher vaccination coverage among urban children than among rural counterparts.<sup>20</sup> Similar patterns have been documented in other Nigerian and sub-Saharan African studies.<sup>6,18,21,22</sup>

The disparity may reflect differences in maternal education, health literacy, access to services, and socioeconomic status. Urban mothers were more likely to have completed secondary education and to utilize maternal health services, factors known to enhance health-seeking behavior. However, a contrasting finding from Bayelsa State showed higher full immunization rates in rural areas than urban areas,<sup>14</sup> suggesting that urban advantage is not universal and may depend on contextual factors such as outreach intensity, community engagement, and health system performance. Despite the relative advantage of urban areas, overall coverage in both settings fell below the 80% target set by Nigeria's National Programme on Immunization (NPI). Suboptimal coverage threatens herd immunity and sustains the transmission of vaccine-preventable diseases, thereby perpetuating avoidable childhood morbidity and mortality. Encouragingly, coverage levels observed in this study were higher than those reported in the NDHS 2024 and by Raji et al. (2019) in Sokoto State.<sup>6,20,23</sup> While this may reflect incremental improvements attributable to strengthened routine immunization efforts and partner support, coverage remains insufficient at subnational levels.

A substantial proportion of children in both urban and rural areas had received no immunization. The most frequently cited reasons for non-immunization were spousal opposition, lack of awareness, and religious objections. These findings underscore the influence of gender dynamics and household decision-making structures on child health outcomes. In many households, women are financially dependent on their husbands, and decisions regarding child health are male-dominated. Similar sociocultural barriers have been documented in other studies.<sup>24,25</sup> These findings highlight the need for male-inclusive and community-engaged immunization strategies that address vaccine hesitancy, misinformation, and patriarchal constraints.

In both urban and rural settings, maternal education, paternal occupation, and the presence of an immunization card were independently associated with full immunization status. In urban areas, additional factors, including paternal education, parental social class, antenatal care attendance, place of delivery, postnatal care attendance, and maternal tetanus toxoid vaccination, were also significantly associated. Maternal education emerged as a strong and consistent predictor in both settings. Mothers with formal education were approximately 4 times (urban) and 9 times (rural) more likely to fully immunize their children than mothers with no formal education. This finding aligns with studies from Sokoto, Kaduna, Zimbabwe, and Bangladesh.<sup>26,27,28,29</sup> Although a study in Ghana reported contrasting findings,<sup>35</sup> the broader literature consistently identifies maternal education as a structural determinant of child health. Education likely enhances health literacy, autonomy, confidence in engaging with health services, and receptiveness to vaccination messages.

In the urban group, paternal education and higher social class were positively associated with full immunization. This may reflect the role of household income and decision-making authority in facilitating service utilization. Unlike several previous studies,<sup>27,28,29</sup> paternal education independently predicted immunization status in this urban sample, suggesting that male educational attainment may shape health investment decisions in contexts where men are primary decision-makers. Antenatal care (ANC), facility-based delivery, postnatal care (PNC), and maternal tetanus toxoid vaccination were significantly associated with full immunization in urban areas. These findings are consistent with studies

conducted in Nigeria, Kenya, Zimbabwe, and India.<sup>28,30,31,36</sup> ANC and PNC visits provide opportunities for health education, trust-building, and linkage to immunization services. Mothers who received three or more doses of tetanus toxoid were significantly less likely to have incompletely immunized children, a finding similar to that reported in South East Ethiopia.<sup>33</sup> Repeated health facility contact likely reinforces knowledge, positive attitudes, and adherence to vaccination schedules.

The presence of an immunization card was a strong predictor of full immunization in both settings. Children whose cards were available were five times as likely (urban) and ten times as likely (rural) to be fully immunized. Beyond its role as a documentation tool, card retention may reflect caregiver engagement, continuity of care, and system-level organization. This finding is consistent with studies in Ghana and Kenya.<sup>35, 36</sup> Improving immunization coverage in Sokoto State requires integrated strategies that address educational, sociocultural, and health system barriers. Strengthening women's education and health literacy while actively engaging men through community- and faith-based platforms is essential to reducing spousal opposition and vaccine hesitancy. Maternal health services, particularly antenatal and postnatal care and facility-based delivery, should be leveraged to reinforce immunization counseling and ensure the timely administration of birth dose vaccines. Health system efforts should also promote better retention of home-based immunization records, potentially supported by digital tracking, to minimize missed doses. In addition, targeted rural outreach programs are needed to overcome structural and informational barriers, thereby reducing urban–rural disparities in immunization uptake.

This study contributes to the limited subnational evidence from Northwestern Nigeria by simultaneously examining rural–urban disparities and identifying both shared and setting-specific predictors of immunization uptake. While maternal education and immunization card retention were consistent predictors across settings, health service utilization variables exerted a stronger influence in urban areas. These findings underscore the need for context-sensitive strategies rather than uniform policy prescriptions.

## STUDY LIMITATIONS

This study has limitations. Its cross-sectional design precludes causal inference. Immunization status was partly determined by maternal recall, introducing potential recall bias. Card availability may have influenced the classification of immunization status. Additionally, findings may not be generalizable beyond similar sociocultural settings in Northwestern Nigeria.

## CONCLUSION

This study reveals suboptimal full immunization coverage among children aged 12–59 months in rural and urban communities of Sokoto State, with higher uptake in urban areas. Maternal education and the presence of an immunization card were consistent predictors in both settings, while socioeconomic status and utilization of maternal health services were particularly influential in urban communities. These findings affirm that socio-demographic factors and contact with health services significantly shape immunization outcomes. Improving coverage will require integrated strategies that strengthen female education and health literacy, promote male involvement, leverage antenatal and postnatal care platforms, enhance immunization record retention, and implement targeted rural outreach interventions to reduce disparities and prevent vaccine-preventable diseases.

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Nil.

## Conflict of interest

None declared.

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# Synergistic Effects of Combined High-Fat and High-Sugar Diets on Metabolic, Developmental, and Behavioral Dysfunction in *Drosophila melanogaster*

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## ABSTRACT

**Background:** The rising global prevalence of obesity and type 2 diabetes is closely linked to excessive consumption of dietary fat and sugar. Although *Drosophila melanogaster* is a well-established model for diet-induced metabolic dysfunction, most studies examine high-fat diets (HFDs) or high-sugar diets (HSDs) independently, leaving the combined metabolic effects of these major components of Western diets insufficiently characterized. **Aim:** To compare the metabolic, developmental, and behavioural effects of HFD, HSD, and a combined high-fat/high-sugar diet (HFD+HSD) in *Drosophila melanogaster*. **Methods:** Flies were reared on control, HFD, HSD, or HFD+HSD diets. Developmental timing, larval morphology, adult body weight, locomotor activity, and systemic biochemical parameters were assessed. Expression levels of Brummer (bmm) and Insulin-like peptide 2 (ILP2) were quantified using RT-PCR. Data were analyzed using ANOVA with Post-hoc Tukey's Honestly Significant Difference test in IBM SPSS (Version 23). **Results:** HSD markedly delayed eclosion (23 vs. 11 days in controls) and significantly reduced larval length ( $245.48 \pm 34.81 \mu\text{m}$  vs.  $724.21 \pm 61.28 \mu\text{m}$ ). The combined HFD+HSD diet produced the most pronounced metabolic disturbances, with significant elevations in systemic glucose (male:  $p = 0.004$ ; female:  $p < 0.001$ ) and lipid levels. Locomotor performance was also most severely impaired in the HFD+HSD group. Gene expression analysis revealed significant up-regulation of bmm and ILP2, suggesting enhanced lipid mobilization and disrupted insulin signalling consistent with early obesity-associated metabolic dysregulation. **Conclusion:** Combined exposure to high fat and high sugar induces a stronger metabolic dysfunction phenotype than either diet alone. This integrated *Drosophila* model offers a powerful platform for investigating the multifactorial mechanisms underlying obesity and related metabolic disorders.

**Keywords:** *Drosophila melanogaster*, High-fat diet, High-sugar diet, Metabolic dysfunction, Insulin signaling

## INTRODUCTION

Metabolic disorders, particularly obesity and type 2 diabetes (T2D), represent one of the most pressing global public health challenges of the twenty-first century. Their rapidly increasing prevalence has been strongly linked to major shifts in dietary patterns, especially the widespread consumption of energy-dense Western-style diets rich in saturated fats and refined sugars.<sup>1</sup> Excess intake of these macronutrients disrupts metabolic homeostasis and contributes to the development of insulin resistance, dyslipidemia, and chronic metabolic inflammation. Understanding how dietary fat and sugar interact to drive these pathological processes has therefore become a

major focus of contemporary biomedical research. While mammalian models have traditionally been used to investigate diet-induced metabolic disease, they are costly, time-consuming, and raise ethical concerns, underscoring the importance of complementary model systems that enable rapid, controlled experimentation.<sup>2-4</sup>

The fruit fly, *Drosophila melanogaster*, has emerged as a powerful and widely accepted model organism for investigating metabolic regulation and diet-induced metabolic dysfunction. This model is particularly valuable because many fundamental metabolic pathways are

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evolutionarily conserved between flies and mammals, including those involved in insulin signaling, lipid metabolism, and energy homeostasis.<sup>2-4</sup> In addition, *Drosophila* offers several experimental advantages, including a short life cycle, well-characterized genetics, and the ability to perform high-throughput dietary and genetic manipulations. These attributes have enabled researchers to explore the molecular and physiological basis of metabolic disorders with remarkable efficiency. Dietary manipulation in *Drosophila* has been extensively used to model obesity- and diabetes-like phenotypes. Experimental exposure to high-fat diets (HFDs) or high-sugar diets (HSDs) can reproduce many features of metabolic disease observed in mammalian systems, including increased triglyceride accumulation, altered carbohydrate metabolism, insulin resistance, and shortened lifespan.<sup>5-8</sup>

High-fat feeding in flies has been associated with abnormal lipid storage and systemic metabolic disruption,<sup>5,6</sup> while high-sugar diets have been shown to induce hyperglycemia-like states and impair insulin signaling pathways.<sup>7</sup> These diet-induced phenotypes demonstrate that *Drosophila* provides a reliable platform for investigating the metabolic consequences of excessive nutrient intake. Despite these advances, important inconsistencies remain in the literature regarding the metabolic effects of single-macronutrient dietary models. For example, while several studies report that HFD exposure leads to pronounced metabolic abnormalities, others have observed more variable outcomes, including inconsistent effects on circulating glucose levels and insulin resistance.<sup>5,6,8</sup> Similarly, the metabolic consequences of HSD exposure are not always uniform across experimental settings, with evidence suggesting that the degree of insulin resistance induced by high-sugar feeding may vary depending on genotype, sex, and environmental conditions.<sup>9</sup> These discrepancies complicate the interpretation of findings and highlight the complexity of nutrient–metabolism interactions.

A key limitation of many existing experimental models is that they focus primarily on the effects of a single macronutrient in isolation. In reality, however, modern human diets rarely involve excessive consumption of only fat or only sugar. Instead, Western dietary patterns typically contain high levels of both macronutrients simultaneously. The combined intake of dietary fat and sugar may therefore exert interactive effects on metabolic regulation that cannot be adequately captured by single-

diet models. Although some studies in *Drosophila* have explored "Western diet" paradigms that incorporate multiple nutrient components,<sup>10-12</sup> comprehensive comparisons of the independent and combined effects of HFD and HSD across multiple physiological endpoints remain relatively limited. Consequently, it remains unclear whether the metabolic consequences of combined diets reflect simple additive effects or produce synergistic interactions that exacerbate metabolic dysfunction.

In addition to metabolic disturbances, dietary imbalance can also influence developmental and physiological processes in *Drosophila*. Nutritional composition during larval development has been shown to affect growth, developmental timing, and adult physiological traits. Similarly, dietary excess can alter behavioral outcomes such as locomotor activity, reflecting the close integration between metabolic regulation and neural function. These diverse phenotypic outcomes underscore the importance of examining diet-induced effects across multiple biological levels rather than focusing solely on metabolic markers.<sup>10-12</sup> Given these considerations, a systematic evaluation of combined exposure to dietary fat and sugar is essential to improve the translational relevance of *Drosophila* metabolic models. In the present study, we addressed this gap by directly comparing the effects of a high-fat diet (HFD), a high-sugar diet (HSD), and a combined high-fat/high-sugar diet (HFD+HSD) in *Drosophila melanogaster*. Using a comprehensive experimental framework, we assessed developmental timing, larval morphology, adult body weight, locomotor behavior, and key biochemical indicators of metabolic function. Through this integrated approach, our study aimed to clarify the relative contributions of dietary fat and sugar to metabolic dysfunction and to determine whether their combined exposure produces enhanced pathological effects.

## MATERIALS AND METHODS

### *Drosophila* Media Preparation

A standard cornmeal-based medium was prepared by boiling agar-agar in distilled water, mixing in cornmeal and yeast, and then adding methyl paraben dissolved in ethanol as a preservative once the mixture had cooled to approximately 65°C. Dietary modifications were incorporated into this base medium. For the HFD, 2% (w/w) coconut oil was added. For the HSD, 30% (w/w) sucrose was included. For the combined HFD+HSD, portions of HFD and HSD media were mixed to achieve

final concentrations of 1% coconut oil and 15% sucrose. All diets were dispensed into sterile *Drosophila* vials to a depth of 3–4 cm and allowed to solidify at room temperature before use.

### ***Drosophila* Stocks**

*Drosophila* stocks (Harwich strain) were obtained from the *Drosophila* Laboratory of the Centre for Advanced Medical Research and Training (CAMRET), Usmanu Danfodiyo University, Sokoto, Nigeria.

### **Experimental Procedure**

Adult flies were transferred into freshly prepared cornmeal medium and allowed to mate and lay eggs for 24–48 hours before being removed. The eggs were reared to adulthood and, soon after eclosion, flies were randomly assigned to one of four experimental diets using a random number allocation approach: (i) standard cornmeal (control), (ii) HFD, (iii) HSD, and (iv) Combined high-fat/high-sugar diet (HFD+HSD). Randomisation was performed by assigning sequential numeric codes to newly eclosed flies and using a computer-generated random number table to allocate each fly to a dietary group. All subsequent biochemical and gene expression analyses were conducted with the analyst blinded to group allocation; vials were labelled with numeric codes, and the allocation key was withheld until after data collection was complete.

The flies were maintained on their assigned diets under standard laboratory conditions (25°C, 60% relative humidity, 12–14 h light/10–12 h dark cycle). The flies were allowed to mate freely and lay eggs. After 5 days, the adult flies were removed. Development of these eggs was monitored across larval, pupal, and adult stages. Larval morphology, including length and width, was measured and recorded at the third instar stage. The number of days to eclosion from each dietary condition was recorded. Adult flies were separated by sex, maintained on their respective diets for seven days, and then grouped in batches of ten for further assessment. They were thereafter weighed, and locomotor activity was assessed using the negative geotaxis assay. Flies were then homogenized for biochemical analyses of glucose, triglycerides, and total cholesterol, as well as gene expression studies. Three independent biological cohorts of 10 flies per dietary group were used ( $n = 3$ ), giving a total of 30 flies per group per sex.

### **Biochemical Assays**

#### **Test for Glucose**

*Drosophila* glucose levels were measured using the Glucose Oxidase (GO) method, a colorimetric-based enzymatic assay.

#### **Test for Lipids**

A coupled colorimetric method was used for triglyceride assaying, while the Amplex Red Cholesterol Kit was used for total cholesterol estimation.

### **Nucleic Acid Extraction**

Total RNA was extracted from homogenised fly samples using the DAAN Gene Extraction Kit, following the manufacturer's guidelines. RNA integrity and concentration were assessed prior to downstream analysis.

#### **Reverse Transcription and Real-Time PCR**

Extracted RNA was reverse-transcribed to complementary DNA (cDNA) using a one-step RT-PCR approach (SYBR chemistry). The housekeeping gene *rp49* (*RpL32*; NCBI Reference Sequence: NM\_079505) was used as the endogenous reference gene for normalisation, consistent with its widely validated use in *Drosophila melanogaster* gene expression studies. Prior to use, the stability of *rp49* expression was confirmed by calculating the coefficient of variation (CV) of Ct values across all experimental dietary groups; a CV of less than 1% was observed, confirming its suitability as a stable reference.

#### **RT-PCR Procedure**

Target genes and their respective forward and reverse primers are listed in Table 1. PCR primers for all target genes (both forward and reverse) were designed using the NCBI Primer-BLAST tool and Primer3 software, and were synthesized by Inqaba Biotec Nigeria. Gene-specific RT-PCR cycling conditions were as follows. For *ILP2*: annealing at 58°C for 30 seconds, 40 cycles. For *Bmm*: annealing at 60°C for 30 seconds, 38 cycles. For the reference gene *rp49*: annealing at 57°C for 30 seconds, 40 cycles. Conditions common to all assays were: pre-denaturation at 95°C for 30 seconds; denaturation at 95°C for 15 seconds; and extension at 72°C for 30 seconds. For each RT-PCR run, each reaction comprised 2 µl template nucleic acid, 10 µl one-step RT-PCR master mix (SYBR chemistry), 2 µl synthetic primer, and 6 µl molecular-grade PCR water (total reaction volume: 20 µl). The

analysis threshold was set at 0.02. All experiments were performed in triplicate. Ct values were analyzed using the 2<sup>-DDCt</sup> (Livak) method to quantify fold changes in mRNA levels, normalized to the *rp49* reference gene.

### Data Analysis

Data were collected, cleaned, entered, and analyzed using SPSS version 23 and Microsoft Excel (Office 16). A one-way analysis of variance (ANOVA) was used to determine statistically significant differences among the four dietary groups for each outcome variable. Where a statistically

significant omnibus ANOVA result was obtained ( $p < 0.05$ ), pairwise comparisons were performed using Tukey's Honest Significant Difference (HSD) post-hoc test to identify which specific group pairs differed significantly. This post-hoc test was selected for its robustness in controlling the family-wise error rate when making multiple comparisons across groups. Detailed results of the post-hoc comparisons are presented in the Results section. All data are reported as mean  $\pm$  standard deviation (SD). A  $p$ -value of  $< 0.05$  was considered statistically significant.

**Table 1: Target genes with forward and reverse primers**

| Gene (NCBI Reference Sequence)                    | Annealing Temp.  | Forward Primer (5'3') | Reverse Primer (5'3') |
|---------------------------------------------------|------------------|-----------------------|-----------------------|
| ILP-2 (NM_079288.3)                               | 58°C / 40 cycles | GTGAAGTTGGCCCAAGGAAC  | CAAACGTCAGGGGATTGAGG  |
| Bmm (NM_140466.2)                                 | 60°C / 38 cycles | GCTGTCTCCTCTGCGATTTC  | TCACCACCCTGAAGAAGTCC  |
| <i>rp49/RpL32</i> (NM_079505)<br>[Reference Gene] | 57°C / 40 cycles | GACGCTTCAAGGGACAGTATC | AAACGCGGTCTTCATGAG    |

**Key:** HFD: High Fat Diet; HSD: High Sugar Diet; HFD+HSD: High Fat/High Sugar Diet

## RESULTS

### Length and Width of the Third Instar Larva

The lengths of ten (10) third instar larvae feeding on the different diets were taken. The means of the length were  $724.21 \pm 61.28$ ,  $776.34 \pm 119.26$ ,  $245.48 \pm 34.81$ ,  $378.03 \pm 44.75$  for the control diet, high fat diet, high sugar diet, and high fat/high sugar diet, respectively. The mean of the control diet is similar to that of the high-fat diet ( $p=0.118$ ) but significantly higher than that of the high sugar diet ( $p<0.001$ ), and high-fat/high sugar diet ( $p<0.001$ ). The mean of the high-fat diet is significantly higher than that of the high-sugar diet ( $p=0.000$ ), and the high-fat/high-sugar diet ( $p=0.000$ ), while the high-sugar diet is significantly lower than that of the high-fat/high-sugar diet ( $p=0.000$ ).

The means of the widths are  $171.52 \pm 27.80$ ,  $164.61 \pm 15.03$ ,  $51.10 \pm 6.72$ , and  $77.43 \pm 10.47$  for the control diet, high-fat diet, high-sugar diet, and high-fat/high-sugar diet, respectively. The mean of the control diet is similar to that of the high-fat diet ( $p=0.369$ ) but significantly higher than that of the high sugar diet ( $p<0.001$ ), and the high-fat/high sugar diet ( $p<0.001$ ). The mean of the high-fat diet is significantly higher than that of the high-sugar diet ( $p=0.000$ ), and the high-fat/high-sugar diet ( $p=0.000$ ), while the high-sugar diet is

significantly lower than that of the high-fat/high-sugar diet ( $p=0.001$ ). In both length and width, the High Sugar diet produced the smallest larvae overall, indicating it is the most detrimental diet for physical development in this stage, followed by HFD+HSD (Table 2 and Figure 1).

### Eclosion

The number of days before eclosion of the *Drosophila* differs significantly with the control diet (11 days), high-fat diet (12 days), high-fat/high-sugar diet (14 days), and high-sugar diet (23 days).

### Weight by Diet and Sex

In both sexes, consumption of the High-Fat Diet (HFD), High-Sugar Diet (HSD), and their combination (HFD+HSD) led to increased weight compared with the Control group. Females exhibited significantly higher absolute weights across all categories compared to males. The average weight of the adult male fly in the control group range from 4.8mg to 5.1mg with a mean of  $4.97 \pm 0.15$ mg while that of the flies in the HFD group range from 5.4mg to 6.1mg with a mean of  $5.77 \pm 0.35$ mg, and that of the High-fat/high-sugar diet (HFD+HSD) group range from 6.4mg to 7mg with a mean of  $6.60 \pm 0.35$ mg. High sugar diet adult male flies' weight ranges from 6.0mg to 6.7mg with a mean of  $6.34 \pm 0.38$ mg



(control<HSD with  $p=0.001$ , HFD<HSD with  $p=0.076$ , and HSD<HFD+HSD with  $p=0.641$ ). There are significant differences in the means of the fly diet groups (control<HFD with  $p=0.037$ , control<HFD+HSD with  $p=0.000$ , and HFD<HFD+HSD with  $p=0.030$ ). The average weight of the female fly in the control group range from 6.4mg to 7.3mg with a mean of  $7.00\pm0.51$ mg while that of the flies in the HFD group range from 8.4mg to 9.5mg with a mean of  $9.07\pm0.58$ mg, and that of the High-fat/high-sugar diet (HFD+HSD) group range from 8.4mg to 9.5mg with a mean of  $8.87\pm0.56$ mg. High sugar diet ranges from 7.5mg to 8.2mg with a mean of  $7.8\pm0.36$ mg (control<HSD with  $p=0.037$ , HSD<HFD with  $p=0.002$ , and HSD<HFD+HSD with  $p=0.008$ ). There are significant differences between the weight of the female flies in the control diet group and that of HFD or HFD+HSD (control<HFD with  $p=0.000$ , control<HFD+HSD with  $p=0.000$ ), but there is no difference in the means of the HFD and HFD+HSD ( $p=0.577$ ) (Figure 2).

### Negative Geotaxis by Diet and Sex

The values recorded for the three trials per group indicate that the control group exhibits consistently high performance, with a score of 10 in most trials and an average score of 99%, suggesting normal motor and neurological function. The HFD shows a similar score range, 8 to 10, with an average of 97% ( $p=0.709$ ), while the HSD shows a range of 6 to 9, with an average of 75% ( $p=0.009$ ). The HFD+HSD groups exhibit a more significant decline in performance, with scores ranging from 7 to 10 and an average of 83%. This suggests that this group has a more pronounced negative effect on the flies' climbing ability compared to the control ( $p=0.032$ ) and the HFD ( $p=0.057$ ). The values recorded for the three trials per group indicate that the control group exhibits consistently high performance, with a score of 10 in most trials and an average score of 99%, suggesting normal motor and neurological function.

The HFD+HSD show similar scores, ranging from 7 to 10, with an average of 93% ( $p=0.087$ ), while the HSD shows scores ranging from 6 to 9, with an average of 73% ( $p=0.000$ ). The HFD groups exhibit a greater decline in performance among female flies, with scores ranging from 7 to 10 and an average of 88%. This suggests that this group has a more pronounced negative effect on female flies' climbing ability than the control ( $p=0.015$ ) and the HFD+HSD ( $p=0.284$ ). However, the High Sugar

Diet (HSD) caused the most drastic drop in climbing ability ( $p<0.01$ ) in both sexes (Figure 3).

### Metabolic Measurements in Male *Drosophila*

Control males showed an average glucose level of 66.40 mg/dl, while HFD males had an average glucose level of 78.79 mg/dl. The HFD+HSD male flies have an average glucose level of 90.82 mg/dl, and the HSD flies have an average glucose level of 30.30 mg/dl. In general, the mean glucose level of the control group of flies in males is less than that of the HFD male group ( $p=0.094$ ) and that of the HFD+HSD male group ( $p=0.004$ ), although there is no significant difference exists between the HFD group and that of the HFD+HSD group of flies ( $p=0.102$ ). Control males had an average triglyceride level of 114.29mg/dL, while HFD males had an average triglyceride level of 161.22mg/dL. The HFD+HSD and HSD male flies have lower average triglyceride levels of 93.88mg/dL and 102.04mg/dL, respectively. The mean triglyceride level of the control group of flies in males is less than that of the HFD male group ( $p=0.071$ ) but higher than that of the HFD+HSD male group ( $p=0.405$ ).

There is a significant difference between the HFD group and the HFD+HSD group of flies ( $p=0.015$ ). Control males had an average Total cholesterol level of 66.40mg/dL, while HFD males had an average Total cholesterol level of 78.79mg/dL. The HSD male flies have a lower average Total cholesterol level of 35.20mg/dl, while HFD+HSD have an average Total cholesterol level of 90.82mg/dl. The mean of the total cholesterol level of the control group of flies in males is less than that of the HFD male group ( $p=0.094$ ) and that of the HFD+HSD male group ( $p=0.004$ ), and there is no significant difference between the HFD group and that of the HFD+HSD group of flies ( $p=0.102$ ). In males, the combination diet (HFD+HSD) showed a highly significant increase over Control ( $p=0.004$ ). The High Sugar Diet (HSD) alone resulted in significantly lower glucose levels ( $p=0.000$ ), the HFD increased triglycerides (161.22 mg/dl), but the addition of sugar (HFD+HSD) led to a significant reduction (93.88 mg/dl) compared to the fat-only group ( $p=0.015$ ). Total cholesterol followed a pattern similar to glucose. Significant increases were seen in the HFD+HSD group for males ( $p=0.004$ ) (Figure 4).



### Metabolic Measurements in Female *Drosophila*

The control female flies have an average glucose of 82.44 mg/dl, while the HFD females have a significantly higher average of 105.70 mg/dl, and the HFD+HSD female flies have an even higher average of 132.89 mg/dl. The HSD females have an average glucose level of 32.35 mg/dl. In the female group of flies, it is observed that the control group glucose value is significantly lower than that of the HFD group ( $p=0.005$ ) and that of the HFD+HSD group of flies ( $p=0.000$ ), while that of the HFD is less than that of the HFD+HSD ( $p=0.002$ ). The control female flies have average triglycerides of 102.04mg/dl, while the HFD females have a significantly higher average of 190.48mg/dl, and the HFD+HSD female flies have an even higher average of 194.56mg/dl. It is observed in the female group of flies that the control group's triglyceride value is significantly lower than that of the HFD group ( $p=0.003$ ) and that of the HFD+HSD group of flies ( $p=0.002$ ), while that of the HFD is less than that of the HFD+HSD ( $p=0.866$ ). HSD female flies have a lower average triglyceride level of 91.84mg/dl.

The control female flies have an average Total cholesterol of 82.44mg/dl, while the HFD females have a significantly higher average of 105.70mg/dl, and the HFD+HSD female flies have an even higher average of 132.89mg/dl. The HSD female flies have a lower average Total cholesterol level of 30.84mg/dl. It is observed that in the female group of flies, the control group's total cholesterol value is significantly lower than that of the HFD group ( $p=0.005$ ) and that of the HFD+HSD group of flies ( $p=0.000$ ), while that of the HFD is less than that of the HFD+HSD ( $p=0.002$ ). Females were more severely affected, with both HFD ( $p=0.005$ ) and HFD+HSD ( $p=0.000$ ) showing dramatic increases.

The High Sugar Diet (HSD) alone resulted in significantly lower glucose levels ( $p=0.000$ ), and HSD-only flies maintained significantly lower cholesterol levels compared to all other high-calorie groups (Figure 5).

### Brummer Gene Expression

Brummer (Bmm) gene expression differed by diet and sex in *Drosophila*. For the male *Drosophila*, there is a 1.7-fold increment in the expression of the bmm gene in those fed on HFD ( $p=0.703$ ) and about a 3.8-fold increment in the expression of the bmm gene in those fed on HFD+HSD ( $p=0.141$ ). While for the female *Drosophila*, there is a 1.7-fold increment in the expression of bmm gene in those fed on HFD ( $p=0.297$ ) and about 1.4-fold increments in the expression of bmm gene in those fed on HFD+HSD ( $p=0.579$ ). The bmm gene expression of flies fed on HSD was 10.0-fold and 13.0-fold significantly up-regulated in both male and female *Drosophila*, respectively ( $p=0.000$ ) (Figure 6).

### Insulin-like Peptide 2 Gene Expression

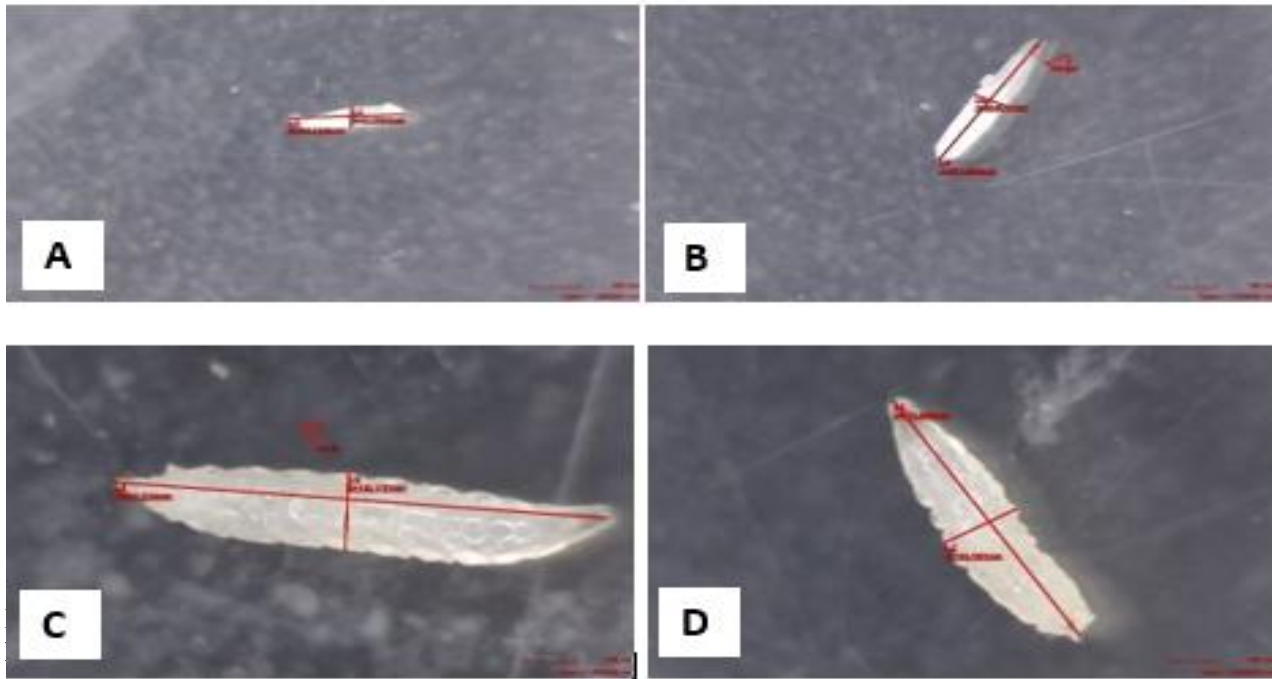
For the male *Drosophila*, there is a 1.4-fold increment in the expression of the ILP2 gene in those fed on HFD ( $p=0.121$ ) and about 1.7-fold increments in the expression of ILP2 gene in those fed on HFD+HSD ( $p=0.022$ ) and 4.5-fold increments in the expression of ILP2 gene in those fed on HSD ( $p=0.000$ ) only. While for the female *Drosophila*, there is a 1.4-fold downregulation in the expression of ILP2 gene in those that feed on HFD ( $p=0.100$ ), and about 1.5-fold up regulation in the expression of ILP2 gene in that feed on HFD+HSD ( $p=0.069$ ) and about 7.7-fold up regulation in the expression of ILP2 gene in that feed on HSD ( $p=0.000$ ) (Figure 7).

**Table 2: Length and Width of the Third Instar Larva**

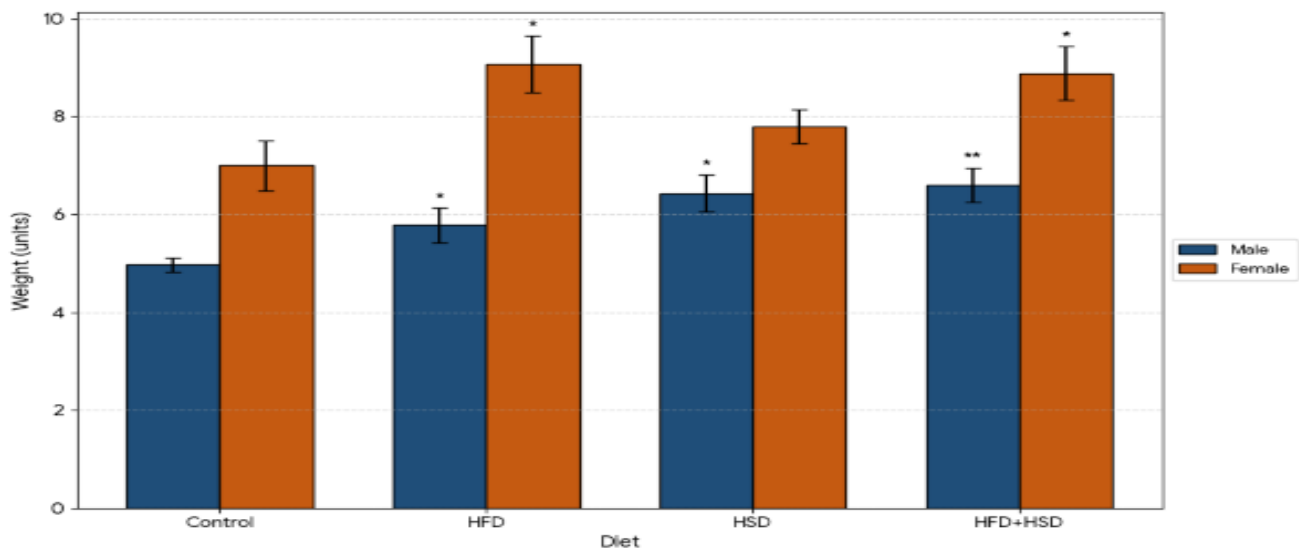
| Group              | Length                   |         | Width                    |         |
|--------------------|--------------------------|---------|--------------------------|---------|
|                    | Mean $\pm$ SD ( $\mu$ m) | P-value | Mean $\pm$ SD ( $\mu$ m) | P-value |
| Control ( $\mu$ m) | 724.21 $\pm$ 61.28       |         | 171.52 $\pm$ 27.80       |         |
| HFD ( $\mu$ m)     | 776.34 $\pm$ 119.26      | 0.118   | 164.61 $\pm$ 15.03       | 0.369   |
| HSD ( $\mu$ m)     | 245.48 $\pm$ 34.81       | <0.001  | 51.10 $\pm$ 6.72         | <0.001  |
| HFD+HSD ( $\mu$ m) | 378.03 $\pm$ 44.75       | <0.001  | 77.43 $\pm$ 10.47        | <0.001  |

F-Values are: (F=127.368, P=0.000 for length), (F=128.823, P=0.000 for width)

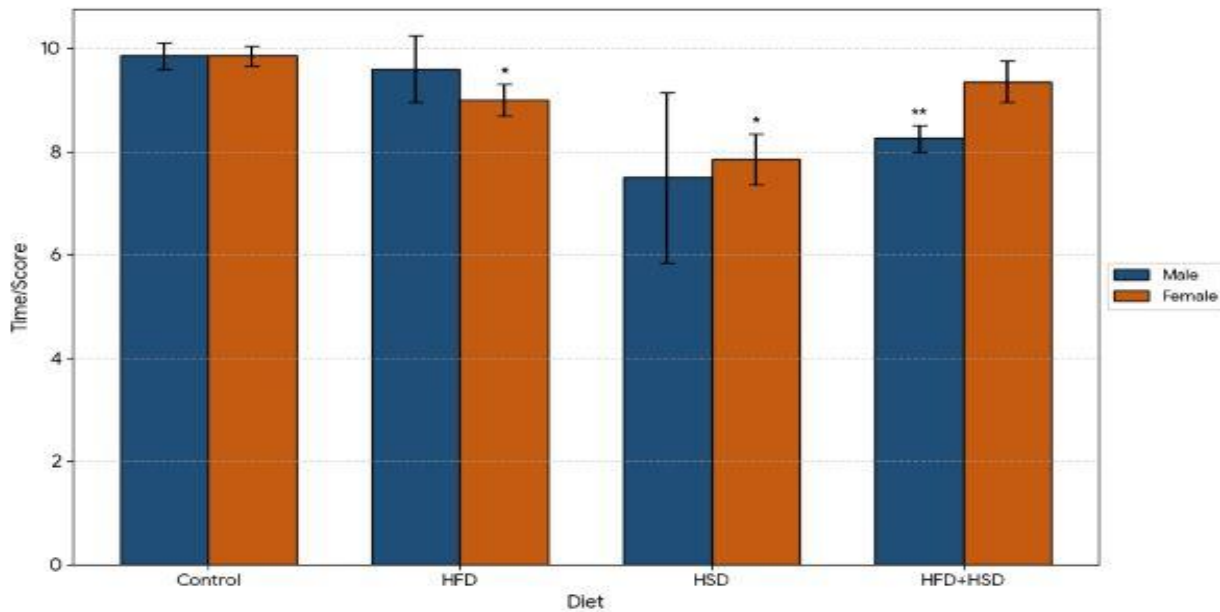
**Key:** HFD: High Fat Diet; HSD: High Sugar Diet; HFD + HSD: High Fat/High Sugar Diet



**Figure 1: Photomicrograph of the Third Instar Larva Showing the Length and Width of Different Diets**  
**Key:** A: High Sugar Diet; B: High Fat Diet/High Sugar Diet; C: Control Diet; D: High Fat Diet



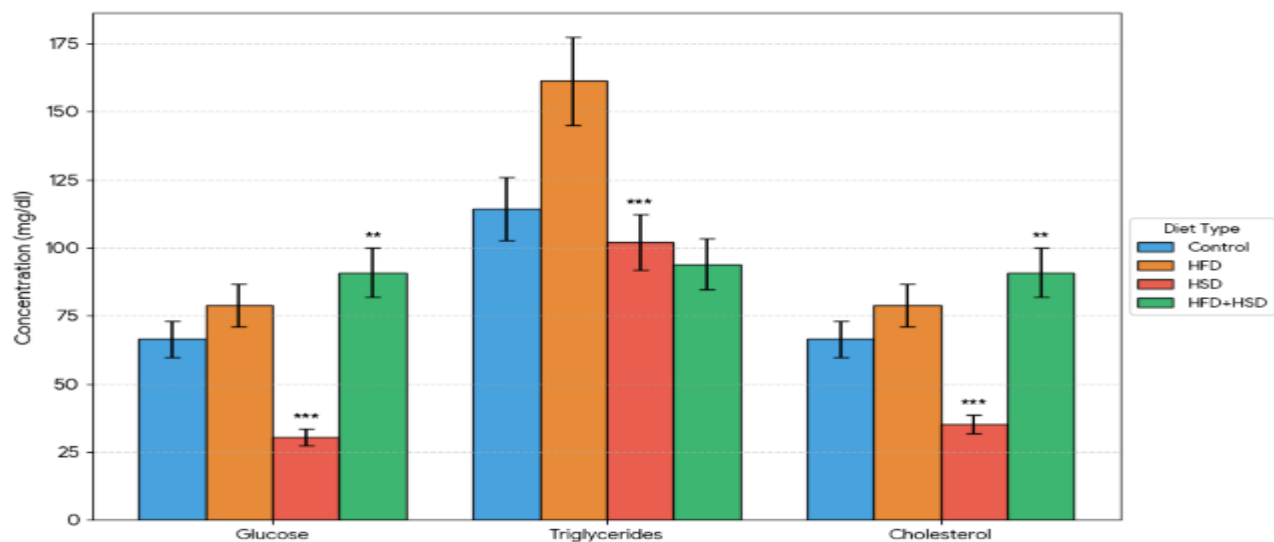
**Figure 2: Adult Weight by Diet and Sex**  
 F-Value is (F=33.669, P=0.000)  
**Key:** HFD: High Fat Diet; HSD: High Sugar Diet; HFD + HSD: High Fat/High Sugar Diet



**Figure 3: Negative Geotaxis by Diet and Sex**

F-Values are ( $F=5.989$ ,  $P=0.024$  for Male), ( $F=17.393$ ,  $P=0.001$  for Female).

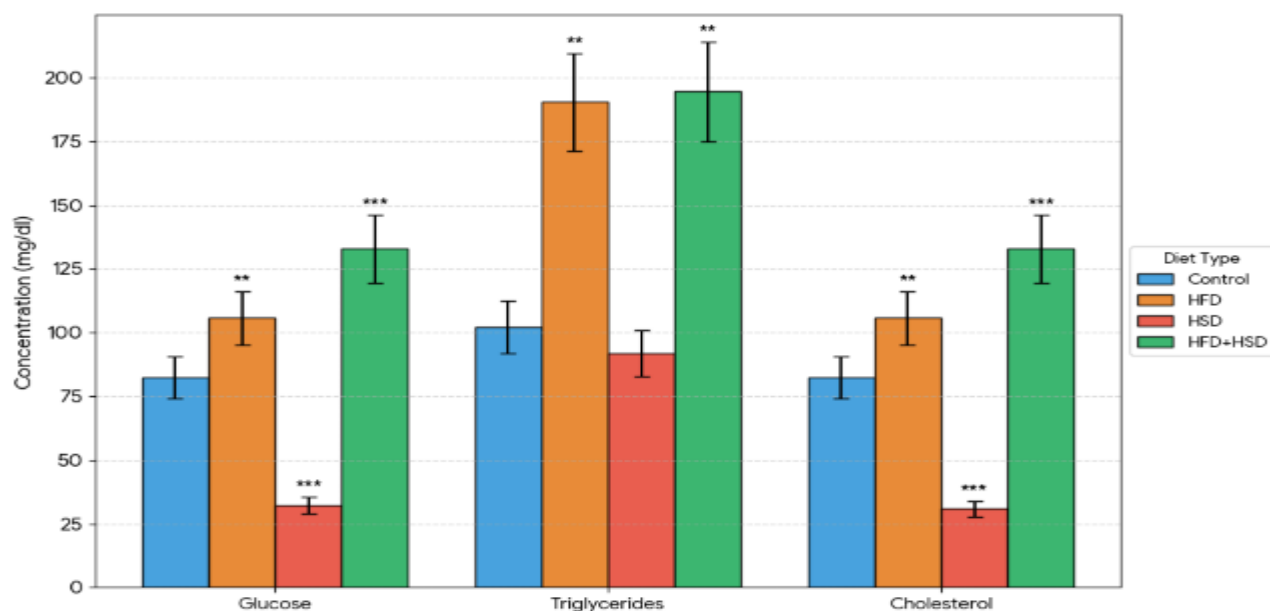
**Key:** HFD: High Fat Diet; HSD: High Sugar Diet; HFD + HSD: High Fat/High Sugar Diet



**Figure 4: Metabolic Measurements in Male *Drosophila***

F-Values are ( $F=23.992$ ,  $P=0.000$  for glucose), ( $F=7.259$ ,  $P=0.002$  for Triglycerides), ( $F=23.992$ ,  $P=0.002$  for Total Cholesterol).

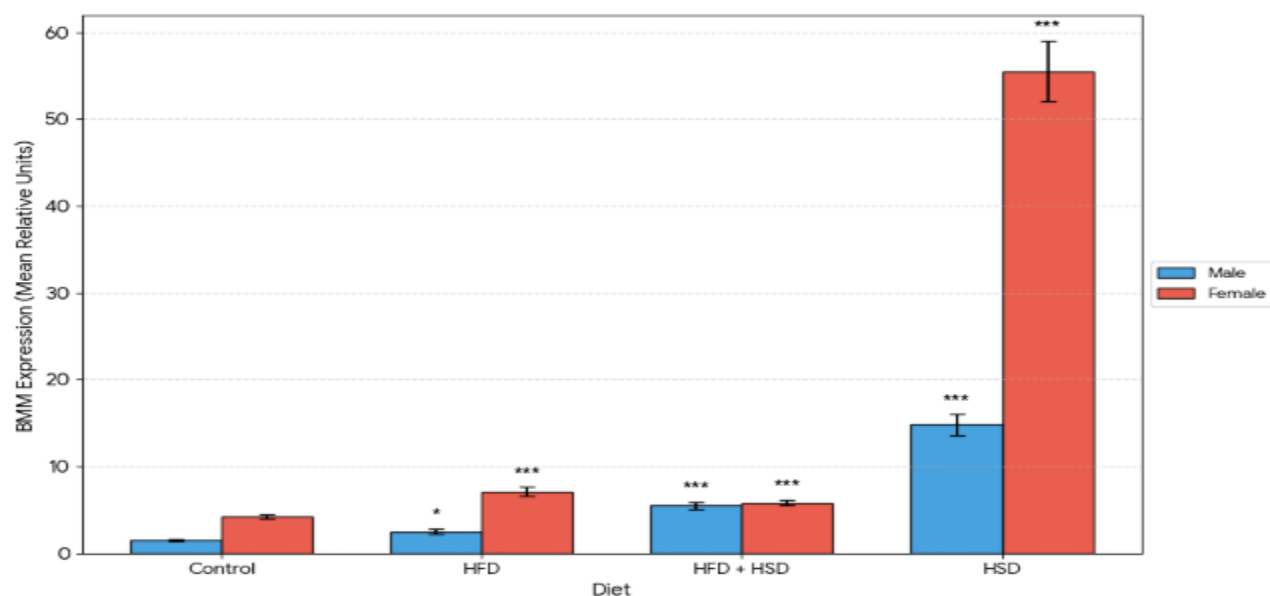
**Key:** HFD: High Fat Diet; HSD: High Sugar Diet; HFD + HSD: High Fat/High Sugar Diet



**Figure 5: Metabolic Measurements in Female *Drosophila***

F-Values are (F=23.992, P=0.000 for glucose), (F=7.259, P=0.002 for Triglycerides), (F=23.992, P=0.002 for Total Cholesterol).

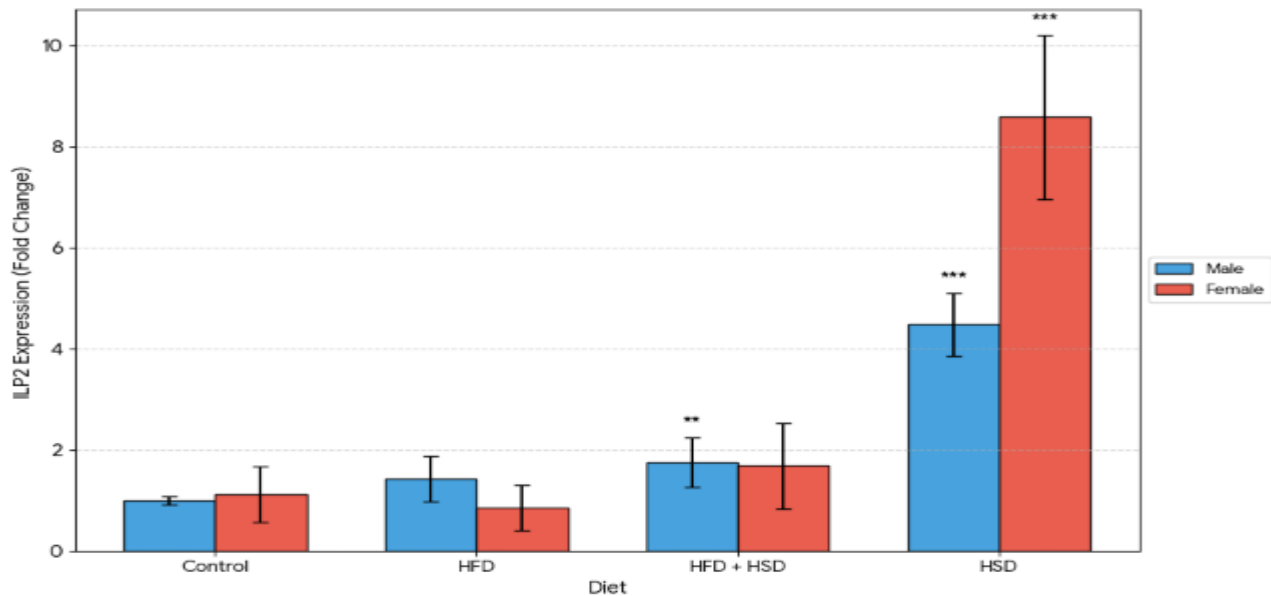
**Key:** HFD: High Fat Diet; HSD: High Sugar Diet; HFD + HSD: High Fat/High Sugar Diet



**Figure 6: Brummer (Bmm) gene expression**

F-Value is (F=1.336, P=0.314)

**Key:** HFD: High Fat Diet; HSD: High Sugar Diet; HFD + HSD: High Fat/High Sugar Diet



**Figure 7: Insulin-like Peptide 2 Gene Expression**

F-Value is (F=2.394, P=0.100)

**Key:** HFD: High Fat Diet; HSD: High Sugar Diet; HFD + HSD: High Fat/High Sugar Diet

## DISCUSSION

This study compared the metabolic, developmental, and behavioural effects of HFD, HSD, and a combined high-fat/high-sugar diet (HFD+HSD) in *Drosophila melanogaster*. Larval growth was significantly influenced by diet composition, as reflected by differences in the length and width of third instar larvae. Larvae reared on the high-sugar diet exhibited the smallest body size, while those exposed to the combined HFD+HSD diet also showed marked reductions compared with the control and HFD groups. In contrast, larvae fed the high-fat diet alone showed growth patterns closer to those of the control group. These observations align with previous studies describing the metabolic and developmental effects of high-fat and high-sugar diets in *Drosophila*.<sup>8,13-15</sup> Although both diets are associated with adverse physiological outcomes,<sup>8</sup> the high-sugar diet produced more pronounced effects on larval development, while the combined HFD+HSD diet showed indications of additive dietary stress.

Dietary composition also influenced developmental timing, particularly the duration to eclosion. Flies maintained on the control diet eclosed at approximately 11 days, whereas those reared on the high-fat diet showed

a slight delay (12 days), and those on the combined HFD+HSD diet exhibited a longer developmental period (14 days). The most pronounced delay occurred in the high-sugar group, where eclosion was observed at approximately 23 days, more than twice that of the control. Previous studies have reported an inverse relationship between dietary sugar concentration and developmental rate in *Drosophila*, suggesting that elevated sugar intake may interfere with physiological processes involved in normal developmental progression.<sup>16,17</sup>

Adult body weight was also influenced by diet and sex. Both male and female flies exposed to high-calorie diets exhibited increased body mass relative to controls, with the largest increases observed in the high-fat and high-fat/high-sugar groups. Females consistently displayed greater body weight than males across all diets, highlighting sexual dimorphism in metabolic responses. Similar sex-dependent differences in fat accumulation and energy storage have been reported in *Drosophila* exposed to obesogenic diets.<sup>6,10</sup> Behavioral assessment using the negative geotaxis assay revealed that dietary excess adversely affects locomotor performance. Although flies on the high-fat diet showed only modest impairment,

those fed high-sugar or combined diets demonstrated more pronounced reductions in climbing ability, with the high-sugar group exhibiting the most severe deficits. These findings align with earlier reports that high-fat and high-sugar diets impair neuromuscular function and accelerate behavioral decline in *Drosophila*.<sup>6,18</sup>

Metabolic measurements further demonstrated diet-dependent alterations in glucose and lipid homeostasis. In both sexes, glucose levels increased markedly in flies exposed to high-fat and combined high-fat/high-sugar diets, indicating diet-induced metabolic stress and potential insulin resistance.<sup>6,8</sup> Interestingly, flies fed high-sugar diets alone exhibited significantly lower glucose levels. This unexpected pattern has been previously reported and may reflect reduced food intake or enhanced metabolic utilization under high-sugar conditions.<sup>9,19</sup> Genotype-specific metabolic responses have also been shown to influence glucose regulation in *Drosophila* exposed to high-sugar diets.<sup>9</sup>

Triglyceride levels also varied according to diet and sex. In males, the high-fat diet produced the highest triglyceride levels, whereas the addition of sugar reduced triglyceride accumulation relative to the fat-only diet. In contrast, female flies exhibited the highest triglyceride levels under the combined high-fat/high-sugar diet. These sex-specific patterns highlight the importance of considering sexual dimorphism in metabolic studies and are consistent with previous work demonstrating differential lipid metabolism between male and female flies.<sup>6,10</sup>

Total cholesterol levels followed a pattern similar to that of glucose, with the highest concentrations observed in flies exposed to the combined diet, particularly in females. These findings reinforce the notion that diets rich in both fat and sugar exacerbate metabolic disturbances more than single-nutrient excess, reflecting interactions between lipid and carbohydrate metabolic pathways. Gene expression analyses provided further insight into the molecular mechanisms underlying these metabolic changes. Expression of the *brummer* (*bmm*) gene, which encodes a key triglyceride lipase involved in lipid mobilization, increased in response to high-calorie diets. Up-regulation was particularly evident in flies exposed to high-fat and combined diets, suggesting activation of lipid-mobilizing pathways in response to excess energy intake. These observations are consistent with evidence

that *bmm* plays a central role in regulating fat storage and breakdown in *Drosophila*.<sup>20</sup> Persistent metabolic overload, however, may overwhelm these compensatory mechanisms, leading to lipid accumulation and metabolic dysfunction.<sup>21</sup>

Similarly, expression of the insulin-like peptide 2 (*ILP2*) gene was altered by dietary interventions. *ILP2*, a key regulator of insulin signaling and metabolic homeostasis, was up-regulated under high-sugar and combined high-fat/high-sugar diets in both sexes. The strongest induction occurred in flies exposed to high-sugar diets, consistent with previous studies showing that excessive carbohydrate intake stimulates insulin signaling pathways in response to metabolic imbalance.<sup>6,8,19</sup> Notably, males displayed a greater increase in *ILP2* expression under combined dietary stress, whereas females showed a more moderate response and even mild down-regulation under the high-fat diet. These differences likely reflect sex-specific regulatory mechanisms in insulin signaling and energy metabolism. Taken together, these findings demonstrate that high-fat and high-sugar diets profoundly influence developmental, metabolic, and behavioral outcomes in *Drosophila melanogaster*. Excess sugar exerted particularly strong effects on growth and locomotor performance, whereas fat-rich diets primarily altered lipid metabolism. The combination of both nutrients produced the most severe metabolic disturbances, highlighting potential synergistic interactions between dietary fat and sugar in driving metabolic dysfunction.

## STUDY LIMITATIONS

The following limitations should be considered when interpreting the findings of this study. Metabolic assessment was limited to a small set of biochemical markers and may not fully capture the complex metabolic alterations associated with high-fat and high-sugar diets in *Drosophila melanogaster*. In addition, the genetic sequence of the Harwich strain used was not verified, which may limit the interpretation of potential genotype-specific responses. The study also did not include lifespan analysis or functional assays to directly assess insulin resistance, and gene expression results were not validated at the protein level. Despite these limitations, the study still provides useful insights into the metabolic, developmental, and behavioral responses of *Drosophila melanogaster* to diets enriched in fat and sugar and highlights potential interactions between these dietary



components in the development of metabolic dysfunction.

## CONCLUSION

This study demonstrates that combined exposure to high-fat and high-sugar diets produces more pronounced metabolic, developmental, and behavioral disturbances in *Drosophila melanogaster* than either diet alone. The combined HFD+HSD condition was associated with greater alterations in growth, metabolic markers, locomotor performance, and diet-responsive gene expression, indicating an amplified metabolic stress response. These findings highlight the value of the combined high-fat/high-sugar dietary model for investigating the interactive effects of excess dietary fat and sugar and for studying mechanisms underlying metabolic disorders such as obesity and type 2 diabetes.

## Source of support

Nil.

## Conflict of interest

None declared.

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# Mirror Movements: A Narrative Review of an Under-recognized Pediatric Disorder in Sub-Saharan Africa

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## ABSTRACT

**Background:** Congenital Mirror Movements are rare neurodevelopmental disorders characterized by involuntary movements on one side of the body that mirror voluntary movements on the opposite side, most commonly involving the hands. Mild mirror movements may occur during normal early childhood development; however, persistence beyond the expected age suggests abnormal corticospinal tract organization. Congenital forms arise from developmental abnormalities in corticospinal tract decussation, while acquired mirror movements may occur after neurological insults such as stroke, traumatic brain injury, or other central nervous system disorders. In Sub-Saharan Africa, limited clinician awareness and restricted pediatric neurology services contribute to under-recognition and delayed diagnosis. **Aim:** This narrative review synthesizes current evidence on the epidemiology, genetic mechanisms, pathophysiology, clinical presentation, diagnosis, and management of mirror movements, with particular attention to challenges and practical considerations in Sub-Saharan Africa. **Methods:** Peer-reviewed literature, including original research articles, case reports, and review papers on mirror movements, was analyzed. Evidence from clinical, neurophysiological, neuroimaging, and genetic studies was examined alongside publications describing pediatric neurology capacity and diagnostic limitations in resource-constrained settings. **Data Synthesis:** Congenital mirror movements are lifelong, non-progressive conditions frequently associated with mutations in genes such as DCC and RAD51, leading to abnormal corticospinal tract development. Acquired mirror movements arise after neurological injury. Both forms may impair fine motor coordination, and diagnosis in resource-limited settings remains largely clinical. **Conclusion:** Mirror movements remain under-recognized in Sub-Saharan Africa. Strengthening clinician awareness, incorporating mirror movement assessment into routine neurological examination, promoting early rehabilitation, and improving pediatric neurology capacity are essential to enhance detection, optimize functional outcomes, and reduce disparities in neurological care.

**Keywords:** Congenital mirror movements, Pediatric movement disorders, Corticospinal tract, Neurodevelopmental disorders, Sub-Saharan Africa

## INTRODUCTION

Congenital Mirror Movements are rare neurodevelopmental motor disorders characterized by involuntary movements on one side of the body that mirror intentional movements performed by the contralateral homologous muscles, most prominently affecting the hands and fingers.<sup>1</sup> These movements occur simultaneously with voluntary activity and typically persist throughout life without progressive neurological deterioration.

Although subtle mirror activity may be observed during early childhood as part of normal motor development, persistent and pronounced mirror movements beyond the expected developmental period are considered pathological and may indicate underlying abnormalities in corticospinal tract organization.<sup>2</sup>

The phenomenon of mirror movements has long attracted clinical interest. Early neurologists in the late nineteenth century described involuntary movements occurring in one limb during voluntary movements of the contralateral limb, distinguishing them from the transient associated movements commonly observed during normal motor maturation in infancy. Subsequent clinical and neurophysiological studies have further clarified the characteristics and mechanisms of mirror movements, underscoring their relevance in both developmental and acquired neurological conditions.<sup>3,4</sup>

Over time, persistent mirror movements were increasingly recognized as a distinct neurological phenomenon rather than a benign developmental variant, with the provision of a widely accepted definition,

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describing it as involuntary synkinetic movements that mirror the intended voluntary activity of the opposite limb.<sup>2</sup>

By the early twentieth century, accumulating clinical observations linked persistent mirror movements to structural and developmental abnormalities of the motor system, leading to the recognition of congenital mirror movements as a distinct clinical entity. Patients typically presented with lifelong mirror movements beginning in early childhood, normal cognitive development, and no progressive neurological disease. In many cases, clinicians also observed a positive family history, suggesting a genetic basis for the disorder.<sup>5</sup>

Subsequent advances in molecular genetics significantly improved the understanding of the condition. A major breakthrough occurred in the early twenty-first century when mutations in the DCC (Deleted in Colorectal Carcinoma) gene were identified as a cause of autosomal dominant congenital mirror movements.<sup>5</sup> Later studies demonstrated additional genetic heterogeneity, including mutations involving the RAD51 gene, further establishing congenital mirror movements as a disorder of axonal guidance and abnormal corticospinal tract development.<sup>2</sup>

Congenital mirror movements are a rare, non-progressive neurodevelopmental motor disorder resulting primarily from abnormal decussation of the corticospinal tract during embryonic development.<sup>1</sup> In affected individuals, motor commands transmitted through the corticospinal tract activate both sides of the body simultaneously, producing symmetrical movements instead of the normal unilateral motor control. In contrast, acquired mirror movements arise later in life following neurological insults such as stroke, traumatic brain injury, or other central nervous system disorders.<sup>6</sup> Although both forms share similar clinical manifestations, their underlying mechanisms and clinical contexts differ. Congenital forms typically appear during infancy or early childhood and remain stable throughout life, whereas acquired mirror movements reflect adaptive or maladaptive changes in motor pathways following injury.<sup>6</sup>

Despite their distinctive clinical features, mirror movements remain under-recognized in routine clinical practice. Because affected individuals usually retain normal intelligence, preserved neurological function, and normal life expectancy, the condition may be overlooked or misinterpreted as a benign motor quirk.<sup>7</sup> In some

settings, individuals with mirror movements may even be perceived as having unusual motor “skills” rather than a neurological disorder. Such misconceptions can delay appropriate evaluation and management.<sup>8</sup>

The challenge of recognition is particularly pronounced in low- and middle-income regions, including Sub-Saharan Africa, where neurological services remain limited. Shortages of trained pediatric neurologists, limited access to specialized diagnostic tools such as neurophysiological testing and neuroimaging, and low awareness of rare neurodevelopmental disorders contribute to diagnostic delays and underreporting.<sup>9</sup> In addition, sociocultural interpretations of unusual motor behaviors may further obscure recognition of the disorder.<sup>10</sup> Consequently, the true burden of congenital mirror movements in Sub-Saharan Africa remains poorly understood.<sup>11</sup>

Given these challenges, a comprehensive synthesis of current knowledge is needed to improve recognition and clinical understanding of this rare disorder in resource-limited settings. This narrative review, therefore, examines the epidemiology, genetic mechanisms, pathophysiology, clinical presentation, diagnosis, and management of mirror movements, with particular emphasis on the contextual challenges and practical considerations relevant to Sub-Saharan Africa. By highlighting the clinical significance of this under-recognized condition, the review aims to contribute to improved awareness, earlier diagnosis, and more effective management within pediatric neurological practice in the region.

## METHODS

A comprehensive literature search was performed in MEDLINE (via PubMed), ScienceDirect, and Google Scholar for full-text articles published up to February 2026. Search terms included combinations of the following keywords: “mirror movements,” “congenital mirror movements,” “corticospinal tract,” “DCC gene,” “RAD51 gene,” “neuroimaging,” “transcranial magnetic stimulation,” and “electromyography.” Additional relevant publications were identified through manual screening of the reference lists of retrieved articles. Studies were eligible for inclusion if they reported clinical, neurophysiological, neuroimaging, or genetic findings related to mirror movements. Eligible study designs included case reports, case series, observational studies, and narrative or systematic reviews published in English.

Studies lacking sufficient methodological detail, non-human studies, conference abstracts, and non-peer-reviewed reports were excluded. Titles and abstracts of retrieved records were screened for relevance, followed by full-text assessment of potentially eligible articles.

Data from included studies were synthesized qualitatively due to heterogeneity in study designs and outcomes. Extracted information focused on clinical assessment methods and grading scales (including the Woods and Teuber classification and the Cohen Mirror Movement Scale), neurophysiological and neuroimaging findings, genetic etiologies, epidemiological patterns, and the functional and psychosocial impact of mirror movements. Particular attention was given to differences between physiological mirror movements observed during normal development and pathological mirror movements associated with neurodevelopmental or neurological disorders. Case reports and small series were included to illustrate rare clinical presentations, but were interpreted with caution regarding prevalence and generalizability. The synthesis also considered recognized gaps in the literature, particularly the limited epidemiological data and restricted access to specialized diagnostic resources in Sub-Saharan Africa, which may contribute to under-recognition of the condition.

## DATA SYNTHESIS

### Epidemiology and Global Distribution

Congenital mirror movements (CMM) are extremely rare neurodevelopmental motor disorders, with an estimated prevalence of below 1 per 1,000,000 individuals. However, this figure likely underestimates the true burden due to mild phenotypes, variable clinical severity, and limited awareness among clinicians. Some reports suggest mirror movements occur in approximately 1 in 8,000 men and 1 in 40,000 women, suggesting possible male predominance, although referral bias and incomplete penetrance may influence these estimates. Familial cases typically follow an autosomal dominant inheritance pattern, though sporadic cases also occur.<sup>1,7,12,13</sup>

The majority of epidemiological and genetic data originate from Europe, particularly France, the United Kingdom, Germany, and the Netherlands, where robust neurology networks and access to molecular diagnostics have facilitated identification of genetically confirmed cases, especially those associated with DCC mutations. North

American reports are largely derived from the United States and Canada, where advanced neuroimaging and neurophysiological techniques support diagnosis. Reports from South America remain limited, mostly confined to isolated case studies, likely reflecting diagnostic challenges rather than true rarity.<sup>1,2,14,15</sup>

Across Asia and the Middle East, both sporadic and familial cases have been reported, including genetically confirmed cases involving DCC mutations. Cultural perceptions of neurological symptoms and delayed clinical presentation may contribute to under-recognition, particularly in milder cases. In Africa, particularly in Sub-Saharan Africa (SSA), published data remain extremely scarce, largely limited to isolated case reports or small hospital-based studies. Limited availability of pediatric neurologists, neuroimaging facilities, and genetic testing contributes to underdiagnosis. There is no biological evidence to suggest lower prevalence in African populations, indicating that low reporting rates likely reflect diagnostic gaps rather than true epidemiological differences.<sup>9,11,16,17</sup>

## Etiology and Genetics

### Congenital Mirror Movements

Congenital mirror movements primarily result from genetic disruptions affecting corticospinal tract development. Several genes involved in axonal guidance and midline crossing have been implicated. Mutations in the DCC (Deleted in Colorectal Carcinoma) gene are the most frequently identified cause, accounting for approximately half of familial cases. DCC encodes a receptor for the axon guidance molecule netrin-1, which directs corticospinal axons across the midline at the pyramidal decussation. Disruption of this process leads to abnormal bilateral corticospinal projections and synchronous activation of homologous muscles during voluntary movement.<sup>2,5,18,19</sup>

Other genetic contributors include mutations in RAD51, a gene involved in DNA repair and neuronal development. RAD51 mutations also interfere with proper corticospinal tract organization, resulting in bilateral innervation of motor neurons. Neurophysiological studies using transcranial magnetic stimulation (TMS) often demonstrate bilateral motor-evoked potentials with symmetric latency in affected individuals, supporting abnormal corticospinal



connectivity. Despite advances in molecular genetics, a proportion of patients exhibit persistent mirror movements without identifiable mutations, suggesting the presence of additional undiscovered genetic mechanisms.<sup>2,3,19,20</sup>

CMM may occur in isolation or as part of syndromic conditions associated with structural developmental anomalies. Reported associations include Klippel–Feil syndrome, Kallmann syndrome, Joubert syndrome, and Moebius syndrome, as well as malformations involving the corpus callosum, brainstem, and cervicomedullary junction. These findings support the concept that abnormal corticospinal tract development and impaired interhemispheric inhibitory pathways contribute to the pathogenesis of mirror movements.<sup>1,20</sup>

### Acquired Mirror Movements

Acquired mirror movements arise from alterations in motor system organization following neurological injury or disease. Unlike congenital forms, acquired mirror movements are often transient and may reflect compensatory neuroplastic reorganization within the motor cortex or corticospinal pathways. Neurological conditions associated with acquired mirror movements include perinatal or childhood stroke, traumatic brain injury, spinal cord injury, brain tumors, and syringomyelia.<sup>4</sup>

Mirror movements have also been observed in several neurodegenerative and movement disorders, including Parkinson's disease, corticobasal degeneration, Huntington's disease, and multiple system atrophy. In such conditions, impaired interhemispheric inhibition or altered motor cortical excitability may contribute to the development of mirrored motor activity. In children, mirror movements are particularly common in hemiplegic cerebral palsy, where abnormal corticospinal tract organization and compensatory cortical reorganization play important roles.<sup>4,6,13</sup>

## Pathophysiology

### Physiological Mirror Movements

Physiological mirror movements are frequently observed during early childhood and are considered part of normal motor development. These movements arise from immaturity of inhibitory circuits between the motor cortices, particularly within transcallosal pathways. During early development, incomplete suppression of

ipsilateral corticospinal projections may result in the involuntary activation of homologous muscles on the contralateral side during voluntary movements.<sup>3,21</sup> Physiological mirror movements are typically mild, task-dependent, and gradually diminish as corticospinal pathways mature and interhemispheric inhibitory control strengthens. Neurophysiological studies using electromyography (EMG) and TMS have demonstrated that mirrored activity may originate from a single cortical source with impulses transmitted through branched corticospinal projections. Diffusion tensor imaging (DTI) studies further support this mechanism by demonstrating transient bilateral corticospinal connectivity during early development.<sup>1,3,22</sup>

### Pathological Mirror Movements

Pathological mirror movements result from persistent abnormalities in corticospinal organization or impaired interhemispheric inhibition. Unlike physiological forms, these movements persist beyond early childhood and are typically involuntary, consistent, and non-suppressible. They often involve symmetrical activation of homologous muscles and are reproducible during voluntary motor tasks.<sup>1</sup> Pathological mirror movements may significantly impair fine motor coordination and bimanual tasks such as writing or object manipulation. Structural abnormalities of the corticospinal tract, defective pyramidal decussation, or reduced transcallosal inhibition have been implicated in their pathogenesis. Therefore, persistent mirror movements represent an important clinical marker of underlying neurological or developmental abnormalities and warrant further evaluation.<sup>3</sup>

## Clinical Features and Classification

Mirror movements are defined as the involuntary activation of muscles on one side of the body that mirror intentional movements on the opposite side. They most commonly affect the hands and fingers and become particularly noticeable during tasks requiring fine motor control, such as writing, buttoning, or using utensils. In many individuals, mirror movements are present from early childhood and remain stable throughout life.<sup>7,23</sup> Based on age of onset, persistence, and underlying mechanism, mirror movements are broadly classified into physiological and pathological forms. Physiological mirror movements occur during early childhood and typically resolve with maturation of corticospinal pathways. In contrast, pathological mirror movements

persist beyond childhood or arise secondary to neurological disease. Clinical features of CMM typically include symmetrical mirrored movements, normal muscle tone and strength, preserved cognition, and absence of progressive neurological deficits. A positive family history may be present, although clinical severity varies widely among affected individuals.<sup>1,23</sup>

### Diagnosis and Assessment

Diagnosis of mirror movements is primarily clinical and relies on a detailed history and focused neurological examination. Key elements include age at onset, distribution of movements, family history, perinatal events, and functional impact on daily activities. Standardized clinical rating scales have been developed to quantify the severity of mirror movements and facilitate comparison across studies.<sup>7</sup> The Woods and Teuber scale is one of the earliest clinical grading systems and assesses mirror movements during standardized motor tasks such as finger tapping and hand opening-closing.

The Cohen Mirror Movement Scale further refined assessment by incorporating task-specific evaluation and correlation with neurophysiological findings. Neurophysiological investigations, including EMG and TMS, provide objective evidence of bilateral corticospinal activation and impaired interhemispheric inhibition. Neuroimaging techniques such as MRI and diffusion tensor imaging are useful for identifying structural abnormalities of the corticospinal tract or associated brain malformations. Genetic testing plays an important role in confirming the diagnosis in familial cases and facilitating genetic counseling. Sequencing of DCC and RAD51 genes can identify pathogenic variants; however, such testing remains largely unavailable in many low-resource settings.<sup>1,3,24-27</sup>

### Management and Prognosis

Management of mirror movements is primarily supportive, as no curative therapy currently exists. Treatment strategies focus on improving functional independence and minimizing the impact of mirrored movements on daily activities. Occupational and physical therapy remain the mainstays of management and may improve fine motor control and coordination through targeted rehabilitation strategies.<sup>1,28</sup> The prognosis of

CMM is generally favorable because the condition is non-progressive and does not affect life expectancy.

Functional outcomes depend on the severity of mirrored movements and access to early rehabilitation. Surgical interventions such as corpus callosotomy were historically attempted but have largely been abandoned due to lack of benefit and potential complications. Patient education and psychosocial support remain essential components of management.<sup>7</sup>

### Impact of Mirror Movements on Children and Adults

Although often benign, mirror movements may significantly affect daily functioning. Persistent mirrored activity can impair bimanual coordination and reduce fine motor precision, making tasks such as writing, typing, or manipulating small objects challenging. These difficulties may affect academic performance in children and occupational productivity in adults.<sup>1</sup> Psychosocial consequences are also important. Children with noticeable mirror movements may experience embarrassment, peer teasing, or reduced participation in sports and group activities. In addition, delayed diagnosis may lead to misinterpretation of symptoms or unnecessary investigations. Recognizing mirror movements as a potential marker of corticospinal tract abnormalities can therefore facilitate early evaluation and appropriate management.<sup>8</sup>

### Challenges and Implications for Sub-Saharan Africa

Mirror movements present unique diagnostic challenges in Sub-Saharan Africa, where neurological services remain limited. The region faces a severe shortage of neurologists and limited access to neuroimaging and neurophysiological testing. As a result, rare conditions such as CMM are frequently overlooked within healthcare systems that prioritize more prevalent neurological disorders such as epilepsy and infectious diseases of the central nervous system. Epidemiological data on movement disorders in SSA are sparse, leading to an underestimation of disease burden and limited health system planning. Cultural beliefs and stigma surrounding neurological symptoms may further delay healthcare-seeking behavior. Persistent mirror movements may significantly impair fine motor tasks such as writing and tool manipulation, potentially affecting educational



attainment and occupational opportunities in resource-limited settings.<sup>9,11,16,17</sup>

### Future Directions

Future research on mirror movements should focus on genotype–phenotype correlations, particularly involving DCC and RAD51 mutations, as well as mechanisms of corticospinal tract plasticity. Advances in neuroimaging and neurophysiology may provide deeper insights into abnormal motor network organization and support the development of targeted rehabilitation strategies.<sup>2</sup> In Sub-Saharan Africa, improving recognition and management of mirror movements will require strengthening neurological training, expanding access to diagnostic services, and integrating rare neurological disorders into national non-communicable disease strategies. Regional research collaborations and improved surveillance systems may help generate locally relevant epidemiological data and support the development of context-appropriate interventions.<sup>9,28–30</sup>

### CONCLUSION

Congenital mirror movements represent a rare but clinically significant neurodevelopmental disorder arising from abnormal corticospinal tract organization and disrupted interhemispheric motor control. Although the condition is increasingly understood through advances in neurogenetics and neurophysiology, it remains under-recognized in many low-resource settings, particularly in Sub-Saharan Africa. This review highlights that most cases can be identified through careful clinical assessment and simple bedside evaluation, even where advanced neuroimaging or genetic testing is unavailable. Improving clinician awareness is therefore critical to preventing misdiagnosis and unnecessary investigations. Early recognition also facilitates appropriate counseling, functional rehabilitation, and monitoring for associated neurological conditions. Strengthening pediatric neurology training, expanding access to diagnostic services, and encouraging regional research will be essential to better characterize the epidemiology and clinical burden of mirror movements in Sub-Saharan Africa and to improve patient outcomes.

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# Prevalence of Tuberculosis–HIV Coinfection, Drug Adherence, and Associated Factors among TB Patients in Specialist Hospital, Sokoto, Nigeria

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## ABSTRACT

**Background:** Tuberculosis (TB) and Human Immunodeficiency Virus (HIV) remain closely intertwined epidemics in sub-Saharan Africa. HIV-associated immunosuppression increases the risk of active TB and may complicate treatment outcomes, while poor adherence to anti-TB therapy undermines disease control. **Aim:** This study determined the prevalence of TB–HIV coinfection, the level of anti-TB drug adherence, and associated factors among TB patients attending the Specialist Hospital, Sokoto, Nigeria. **Materials and Methods:** A hospital-based cross-sectional study was conducted among 187 adult TB patients receiving treatment at the Specialist Hospital, Sokoto. Participants were selected using systematic sampling. Data were collected using a structured, interviewer-administered questionnaire and a review of clinical records. Descriptive statistics, chi-square tests, and multivariate logistic regression analyses were performed using IBM SPSS version 25, with statistical significance set at  $p < 0.05$ . **Results:** The prevalence of TB–HIV coinfection was 19.0%. Coinfection was significantly associated with male sex, non-Hausa ethnicity, formal education, Christianity, and urban residence ( $p < 0.05$ ). Independent predictors included male sex (aOR=2.56; 95% CI: 1.01–6.49), non-Hausa ethnicity (aOR=0.20; 95% CI: 0.07–0.54), and rural residence (aOR=0.43; 95% CI: 0.20–0.93). Overall, 58.8% of participants demonstrated low adherence to anti-TB medications. Drug adherence was significantly associated with family structure, ethnicity, educational status, perceived social support, mood disorders, and coping strategies. Predictors of better adherence included non-formal education (aOR=2.38; 95% CI: 1.12–5.08), monogamous family structure (aOR=2.10; 95% CI: 1.00–4.42), strong perceived family support (aOR=0.45; 95% CI: 0.23–0.88), and active coping strategies. **Conclusion:** TB–HIV coinfection remains a significant burden among TB patients in Sokoto, while adherence to anti-TB therapy is suboptimal. Strengthening adherence support and addressing key sociodemographic and psychosocial determinants may improve treatment outcomes and enhance TB control efforts.

**Keywords:** Tuberculosis–HIV co-infection, Drug adherence, Anti-TB treatment, Prevalence, Nigeria

## INTRODUCTION

Tuberculosis (TB) remains a major global public health challenge and a leading cause of morbidity and mortality worldwide. Despite advances in diagnosis and treatment, TB continues to rank among the top ten causes of death globally and was the second leading infectious killer after COVID-19 in 2020, accounting for approximately 1.5 million deaths annually.<sup>1–4</sup> The burden of TB is disproportionately concentrated in low- and middle-income countries, where socioeconomic disadvantage, malnutrition, overcrowded living conditions, and weak health systems contribute to sustained transmission and adverse outcomes.<sup>5</sup>

Globally, an estimated 10 million people developed TB in 2018, resulting in about 1.4 million deaths, including substantial mortality among individuals living with Human Immunodeficiency Virus (HIV).<sup>6</sup> Men are also reported to experience higher rates of pulmonary TB and TB-related mortality than women in many regions of the world.<sup>7</sup> Sub-Saharan Africa bears a particularly high burden of TB, largely driven by the HIV epidemic. Approximately one-third of the world's population is infected with *Mycobacterium tuberculosis*, with the highest prevalence occurring in regions heavily affected by HIV infection.<sup>8</sup>

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In this context, Nigeria is among the countries with the greatest TB burden globally and ranks among those accounting for the majority of cases worldwide.<sup>8</sup> HIV infection significantly contributes to the TB epidemic by increasing susceptibility to active TB disease, complicating diagnosis and treatment, and worsening clinical outcomes, including treatment failure and mortality.<sup>9</sup> Early detection and prompt initiation of anti-tuberculosis therapy remain critical strategies for reducing transmission, morbidity, and mortality associated with TB.<sup>9</sup>

The interaction between TB and HIV represents one of the most significant syndemics affecting global health. Individuals living with HIV are approximately 30 times more likely to develop active TB compared with HIV-negative individuals.<sup>10</sup> Consequently, HIV infection has contributed substantially to the persistence of the TB epidemic, particularly in regions with high HIV prevalence.<sup>11</sup> Globally, TB–HIV coinfection is associated with considerable morbidity and mortality, and the African region has consistently recorded the highest rates of coinfection.<sup>12</sup> This dual epidemic has important implications for health systems, given the need for integrated prevention, diagnosis, and treatment services.

In Nigeria, several studies have documented varying prevalence rates of TB–HIV coinfection across different regions. Reported prevalence among TB patients ranges from 6.1% in Jos and 9.2% in Ilorin to 28.1% in Ibadan, 35.1–41.2% in Benue, and 25% in Port Harcourt.<sup>13–16</sup> Additional studies have reported prevalence rates of 10.8% in Irrua, 6.4% in Imo, 16.7% in Enugu, 19.8% in Benin City, and 32.8% in Edo State, with a national median prevalence estimated at approximately 17%.<sup>17–19</sup> These variations reflect differences in epidemiological patterns, healthcare access, and underlying socioeconomic conditions across regions.

The relationship between TB and HIV is bidirectional and synergistic. HIV-induced immunosuppression increases the risk of progression from latent to active TB infection, while TB accelerates the progression of HIV disease through chronic immune activation.<sup>20</sup> Several factors have been associated with TB–HIV coinfection, including socioeconomic deprivation, poor nutrition, overcrowded living conditions, substance misuse, and mental health disorders.<sup>7,21</sup> Sociodemographic characteristics such as age, sex, educational status, marital status, and place of

residence have also been implicated as potential determinants of coinfection in different populations.

Effective management of TB, particularly in individuals with HIV coinfection, relies heavily on adherence to long-term treatment regimens. Patients with TB–HIV coinfection often receive complex therapeutic combinations, including anti-tuberculosis drugs and antiretroviral therapy, which may increase pill burden and the likelihood of adverse drug reactions.<sup>22</sup> Poor adherence to treatment is associated with unfavorable outcomes such as treatment failure, relapse, and the emergence of drug-resistant TB.<sup>22</sup> Accurate assessment and improvement of medication adherence, therefore, remain essential components of TB control programs.

Adherence to TB treatment is a multifaceted phenomenon influenced by socioeconomic conditions, health system characteristics, treatment-related factors, disease-related factors, and patient-related behaviors.<sup>22,23</sup> These interacting determinants often create barriers to sustained adherence, particularly in resource-limited settings where social support systems and access to healthcare services may be constrained.<sup>23</sup> Understanding these determinants is crucial for designing targeted interventions aimed at improving treatment outcomes.

Although several studies have investigated TB–HIV coinfection in Nigeria, most have been conducted in the southern and central regions of the country, with relatively limited data available from northern Nigeria.<sup>16</sup> In Sokoto State, evidence regarding the prevalence of TB–HIV coinfection and patterns of drug adherence among TB patients remains scarce. Generating such data is essential for informing context-specific interventions aimed at improving adherence, strengthening integrated TB–HIV care, and optimizing treatment outcomes. Therefore, this study assessed the prevalence of TB–HIV coinfection, the level of drug adherence, and associated factors among TB patients receiving care at the Specialist Hospital, Sokoto, Nigeria.

## MATERIALS AND METHODS

### Study Design, Population, and Area

This was a hospital-based cross-sectional study conducted among adult tuberculosis (TB) patients ( $\geq 18$  years) receiving treatment at the Specialist Hospital, Sokoto, Nigeria, between April 2021 and May 2022. Specialist



Hospital, Sokoto, is a tertiary healthcare facility that provides comprehensive TB and Human Immunodeficiency Virus (HIV) care services, including diagnosis, treatment, and follow-up under the national TB control programme. All eligible TB patients attending the facility during the study period who provided informed consent were considered for enrollment.

### Sample Size Estimation and Sampling Techniques

The sample size was estimated at 196 using the Cochran formula for sample size estimation in cross-sectional studies<sup>24</sup>, based on the 21.6% HIV prevalence<sup>15</sup> among TB patients reported in a previous Nigerian study, a 5% margin of error, and an anticipated 95% response rate. Of the 1,504 TB patients receiving treatment during the study period, eligible participants were selected using a systematic sampling technique until the required sample size was reached.

### Data Collection

Data were collected using a structured interviewer-administered questionnaire and clinical record review forms. The questionnaire consisted of five sections designed to obtain information on participants' sociodemographic characteristics, HIV status, and patterns of adherence to anti-tuberculosis medications. The study instrument was reviewed by senior researchers in the Department of Community Health, Usmanu Danfodiyo University, Sokoto, Nigeria, to ensure content validity. Five trained research assistants supported the data collection process. They were trained on the study objectives, eligibility criteria, participant selection procedures, and administration of the survey instruments. The questionnaire was pretested among 20 TB patients with HIV coinfection attending another TB treatment centre within Sokoto metropolis to identify potential ambiguities and ensure clarity of the questions. Necessary modifications were made to the instrument following the pretest before the commencement of the main study.

### Data Analysis

The returned questionnaires were cross-checked for completeness and consistency before data entry. Data were analyzed using IBM SPSS version 25. Quantitative variables were summarized using mean and standard deviation, while categorical variables were presented as frequencies and percentages. The chi-square test was used to assess associations between sociodemographic

characteristics and the outcomes of interest. Multivariate logistic regression analysis was performed to identify independent predictors of TB–HIV coinfection and drug adherence among the study participants. Statistical significance was set at  $p < 0.05$ .

### Ethical Consideration

Ethical approval for the study was obtained from the Health Research and Ethics Committee of the Specialist Hospital, Sokoto, Nigeria. The purpose and procedures of the study were explained to all participants, and confidentiality of the information provided was assured. Participation was voluntary, and written informed consent was obtained from each participant prior to data collection.

## RESULTS

### Sociodemographic characteristics of participants

A total of 187 participants completed the questionnaire and were included in the analysis. The largest proportion of respondents was aged 30–39 years (47; 25.0%), followed by those aged 20–29 years (23.5%). More than half of the participants were male (106; 56.7%). The majority practiced Islam (164; 87.7%), belonged to the Hausa ethnic group (158; 84.5%), and had Qur'anic education (63; 33.7%). Most respondents were married (118; 63.1%), predominantly in monogamous unions (112; 59.9%), and self-employed (79; 42.2%) [Table 1].

### Prevalence and factors associated with TB–HIV coinfection among participants

Of the 187 participants with complete HIV status data, 35 (19.0%) were coinfecting with TB and HIV [Figure 1]. TB–HIV coinfection was significantly more prevalent among male participants (26; 24.5%) compared with females (9; 11.1%) ( $p < 0.05$ ). A markedly higher prevalence was observed among Christians (14; 56.5%) compared with Muslims (22; 13.4%) ( $p < 0.05$ ). Coinfection was also significantly more common among non-Hausa ethnic groups (14; 48.3%) compared with Hausa participants (21; 13.3%), among respondents with formal education (21; 30.4%) compared with those with non-formal education (14; 11.9%), and among those residing in urban areas (23; 25.0%) compared with rural residents (12; 12.6%) ( $p < 0.05$  for all). No statistically significant differences were observed in the distribution of TB–HIV coinfection across age group, marital status, type of marriage, or occupation ( $p > 0.05$ ) [Table 2].



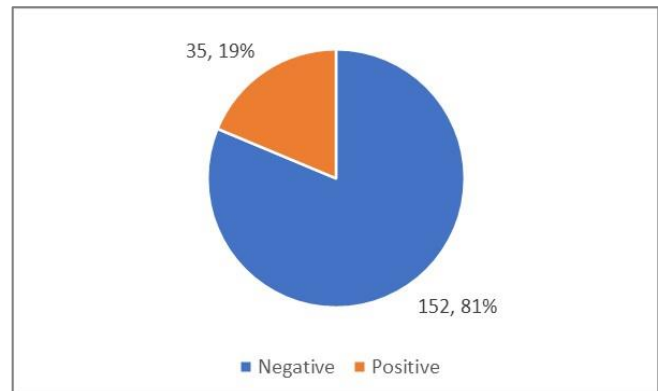
**Table 1: Sociodemographic characteristics of participants**

| Variables                        | Frequency (%) n = 187 |
|----------------------------------|-----------------------|
| Age group (years)                |                       |
| 10-19                            | 15 (8.0)              |
| 20-29                            | 44 (23.5)             |
| 30-39                            | 47 (25.2)             |
| 40-49                            | 41 (21.9)             |
| 50-59                            | 25 (13.4)             |
| ≥60                              | 15 (8.0)              |
| Sex                              |                       |
| Male                             | 106 (56.7)            |
| Female                           | 81 (43.3)             |
| Level of education               |                       |
| No formal education              | 41 (21.9)             |
| Quranic school only              | 63 (33.7)             |
| Primary                          | 14 (7.5)              |
| Secondary                        | 46 (24.6)             |
| Tertiary                         | 23 (12.3)             |
| Marital status                   |                       |
| Single                           | 55 (29.4)             |
| Married                          | 118 (63.1)            |
| Separated                        | 5 (2.7)               |
| Divorced                         | 6 (3.2)               |
| Widowed                          | 3 (1.6)               |
| Type of marriage                 |                       |
| Monogamous                       | 112 (59.9)            |
| Polygamous                       | 75 (40.1)             |
| Tribe                            |                       |
| Hausa                            | 158 (84.5)            |
| Yoruba                           | 18 (9.6)              |
| Igbo                             | 7 (3.7)               |
| Others (e.g., Ibira, Nupe, etc.) | 4 (2.1)               |
| Religion                         |                       |
| Islam                            | 164 (87.7)            |
| Christianity                     | 23 (12.3)             |
| Occupation                       |                       |
| Civil servant                    | 24 (12.8)             |
| Self employed                    | 79 (42.2)             |
| Unemployed                       | 24 (12.8)             |
| Student                          | 25 (13.4)             |
| Housewife                        | 22 (11.8)             |
| Retired                          | 13 (7.0)              |
| Type of settlement               |                       |
| Rural                            | 92 (49.2)             |
| Urban                            | 95 (50.8)             |

### Predictors of TB–HIV coinfection among participants

Multivariate logistic regression analysis identified male sex, ethnicity, and place of residence as significant predictors of TB–HIV coinfection. Male participants had approximately 2.6-fold higher odds of TB–HIV coinfection compared with females (aOR = 2.56; 95% CI: 1.01–6.49;  $p = 0.047$ ). In contrast, participants of Hausa ethnicity were significantly less likely to have TB–HIV coinfection compared with other ethnic groups (aOR =

0.20; 95% CI: 0.07–0.54;  $p = 0.001$ ). Similarly, rural residents had lower odds of TB–HIV coinfection compared with urban residents (OR = 0.43; 95% CI: 0.20–0.93;  $p = 0.033$ ) [Table 3].

**Figure 1: Prevalence of TB–HIV coinfection among participants**

### Prevalence of drug adherence among participants

Among the 187 respondents assessed for treatment adherence, the majority, 110 (58.8%), had low adherence to anti-tuberculosis medication. Seventy-two (38.5%) demonstrated moderate adherence, while only 5 (2.7%) achieved high adherence to treatment [Figure 2].

### Sociodemographic factors associated with drug adherence among participants

Drug adherence was significantly associated with family structure, ethnicity, and educational status [Table 4]. Participants in monogamous marriages were more likely to demonstrate better adherence compared with those in polygamous marriages (47.3% vs 32.0%;  $\chi^2 = 4.353$ ;  $p = 0.037$ ). Similarly, Hausa participants had higher levels of adherence than respondents from other ethnic groups (44.3% vs 24.1%;  $\chi^2 = 4.114$ ;  $p = 0.043$ ). Respondents with non-formal education exhibited significantly better adherence compared with those with formal education (49.2% vs 27.5%;  $\chi^2 = 8.399$ ;  $p = 0.004$ ). However, age, sex, marital status, and occupation were not significantly associated with treatment adherence ( $p > 0.05$ ).

### Psychosocial factors associated with drug adherence among participants

Several psychosocial factors were significantly associated with adherence to TB treatment [Table 5]. Participants with strong perceived family social support demonstrated significantly higher adherence compared with those with weak family support (51.0% vs 30.3%;  $\chi^2 = 8.238$ ;  $p = 0.004$ ). The presence of mood disorders was also associated with adherence, with respondents reporting mood disorders showing higher adherence levels than those without mood disorders (50.6% vs 34.0%;  $\chi^2 = 5.258$ ;  $p = 0.022$ ). Similarly, respondents who reported active coping strategies were more likely to adhere to treatment compared with those without such strategies (33.3% vs 53.4% high/medium adherence;  $\chi^2 = 7.417$ ;  $p = 0.006$ ). In contrast, communication with health workers was not significantly associated with treatment adherence ( $p > 0.05$ ).

### Predictors of drug adherence among participants

Multivariate logistic regression analysis identified several independent predictors of better adherence to TB treatment [Table 6]. Participants with non-formal education had approximately 2.4-fold higher odds of good adherence compared with those with formal education (aOR = 2.38; 95% CI: 1.12–5.08;  $p = 0.025$ ). Respondents in monogamous marriages were also more likely to demonstrate better adherence than those in polygamous unions (aOR = 2.10; 95% CI: 1.00–4.42;  $p = 0.050$ ). Perceived family social support emerged as a protective factor: participants reporting weak family support were less likely to adhere to treatment than those with strong support (aOR = 0.45; 95% CI: 0.23–0.88;  $p = 0.020$ ). Although active coping strategies were associated with improved adherence in bivariate analysis, the association did not reach statistical significance after adjustment (aOR = 1.91; 95% CI: 0.94–3.90;  $p = 0.075$ ). Also, other variables, including age, sex, religion, occupation, marital status, ethnicity, settlement type, and mood disorders, were not significant predictors in the multivariate model.

## DISCUSSION

This study assessed the prevalence of TB–HIV coinfection, treatment adherence, and associated factors among patients with pulmonary tuberculosis attending the Specialist Hospital, Sokoto, Nigeria. The prevalence of TB–HIV coinfection in this study was 19.0%, which is comparable to reports from Maiduguri (19%), Benin City

(19.8%), and Enugu (16.7%), and closely aligns with the Nigerian national median prevalence of approximately 17%.<sup>13,19</sup> However, the prevalence observed in this study is lower than figures reported in Edo (32.8%), Benue (41.2%), and Ibadan (28.1%), as well as in other African countries such as Chad, Tanzania, and Ethiopia, where prevalence rates of 33.2%, 43.6%, and 57.1%, respectively, have been reported.<sup>13,14,19,25</sup> Variations in TB–HIV coinfection prevalence across settings may reflect differences in HIV epidemiology, access to antiretroviral therapy (ART), and the implementation of integrated TB–HIV control programs.<sup>26</sup> Geographic variations in HIV prevalence across African populations may also contribute to these differences.<sup>16,19</sup>

Conversely, the prevalence observed in this study is higher than that reported in several other settings, including Kano (10.5%), Ilorin (9.2%), Ethiopia (7.5%), Iraq (10.3%), India (0.13%), and Pakistan (4.39%).<sup>13,27–29</sup> Such differences may reflect variations in patient characteristics and the quality and accessibility of TB and HIV care services across health systems.<sup>30</sup> In generalized HIV epidemics, the prevalence of HIV among TB patients has been considered an indicator of the maturity of the HIV epidemic and a predictor of the future burden of tuberculosis at the population level.<sup>31</sup> TB–HIV coinfection in this study was significantly more common among male participants, with males having approximately 2.6-fold higher odds of coinfection than females. This finding is consistent with reports from Nigeria and the Democratic Republic of Congo.<sup>6,16,32</sup> The higher prevalence among men has been attributed to biological and behavioral factors influencing exposure risk, health-seeking behavior, and disease detection.<sup>6</sup>

Educational status was also significantly associated with coinfection, with participants with formal education showing a higher prevalence than those without. This finding contrasts with previous studies that reported lower coinfection rates among individuals with higher educational attainment, possibly due to improved health literacy and health-seeking behavior.<sup>33–35</sup> Differences in study settings and population characteristics may partly explain this discrepancy. Place of residence was another significant determinant of TB–HIV coinfection, with urban residents showing higher prevalence than rural residents. Similar observations have been reported in other studies linking urban residence with increased vulnerability to infectious diseases due to environmental and socioeconomic factors.

**Table 2: Factors associated with HIV-TB coinfection among participants**

| Variables                                  | HIV-TB coinfection test |                | Test of significance |
|--------------------------------------------|-------------------------|----------------|----------------------|
|                                            | Positive, n(%)          | Negative, n(%) |                      |
| Age group (years)                          |                         |                |                      |
| 10-39 (n=105)                              | 20 (19.0)               | 85 (81.0)      | $\chi^2 = 0.017$     |
| ≥40 (n = 82)                               | 15 (18.3)               | 67 (81.7)      | p=0.896              |
| Sex                                        |                         |                |                      |
| Male (n=106)                               | 26 (24.5)               | 80 (75.5)      | $\chi^2 = 5.433$     |
| Female (n=81)                              | 9 (11.1)                | 72 (88.9)      | p=0.020*             |
| Religion                                   |                         |                |                      |
| Islam (n=164)                              | 22 (13.4)               | 142 (86.6)     | $\chi^2 = 24.638$    |
| Christianity (n=23)                        | 13 (56.5)               | 10 (43.5)      | P<0.001*             |
| Marital status                             |                         |                |                      |
| Single (n=55)                              | 11 (20.0)               | 44 (60.0)      | $\chi^2 = 0.084$     |
| Married/separated/divorced/widowed (n=132) | 24 (18.2)               | 108 (81.8)     | p=0.771              |
| Type of marriage                           |                         |                |                      |
| Monogamous (n=112)                         | 25 (22.3)               | 87 (77.7)      | $\chi^2 = 2.385$     |
| Polygamous (n=75)                          | 9 (6.9)                 | 65 (86.7)      | p=0.122              |
| Tribe                                      |                         |                |                      |
| Hausa (n=158)                              | 21 (13.3)               | 137 (86.7)     | $\chi^2 = 19.713$    |
| Other tribes (n=29)                        | 14 (48.3)               | 15 (51.7)      | p<0.001*             |
| Education                                  |                         |                |                      |
| Non-formal (n=118)                         | 14 (11.9)               | 104 (88.1)     | $\chi^2 = 9.870$     |
| Formal (n=69)                              | 21 (30.4)               | 48 (69.6)      | p=0.002*             |
| Occupation                                 |                         |                |                      |
| Employed (n=103)                           | 23 (22.3)               | 80 (77.7)      | $\chi^2 = 1.968$     |
| Unemployed (n=84)                          | 12 (14.3)               | 72 (85.7)      | p=0.161              |
| Settlement                                 |                         |                |                      |
| Rural (n=95)                               | 12 (12.6)               | 83 (87.4)      | $\chi^2 = 4.700$     |
| Urban (n=92)                               | 23 (25.0)               | 69 (75.0)      | p=0.030*             |

$\chi^2$ : Pearson's chi square test; \*Statistically significant (p<0.05)

**Table 3: Predictors of HIV-TB coinfection among participants**

| Variables                                                               | aOR   | 95% CI |       | p-value |
|-------------------------------------------------------------------------|-------|--------|-------|---------|
|                                                                         |       | Lower  | Upper |         |
| Age group (years)<br>(10-39 versus ≥40)                                 | 1.256 | 0.461  | 3.424 | 0.656   |
| Sex<br>(Males versus Females)                                           | 2.562 | 1.012  | 6.487 | 0.047   |
| Marital status<br>(Single versus<br>Married/Separated/Divorced/Widowed) | 1.124 | 0.389  | 3.248 | 0.829   |
| Type of marriage<br>(Monogamous versus Polygamous)                      | 1.113 | 0.447  | 2.770 | 0.819   |
| Tribe<br>(Hausa versus Other tribes)                                    | 0.198 | 0.073  | 0.537 | 0.001   |
| Education<br>(Non-formal versus Formal)                                 | 0.478 | 0.204  | 1.121 | 0.090   |
| Occupation<br>(Employed versus Unemployed)                              | 1.558 | 0.648  | 3.745 | 0.322   |
| Settlement<br>(Rural versus Urban)                                      | 0.434 | 0.201  | 0.934 | 0.033   |

aOR: adjusted Odds Ratio, CI: Confidence Interval

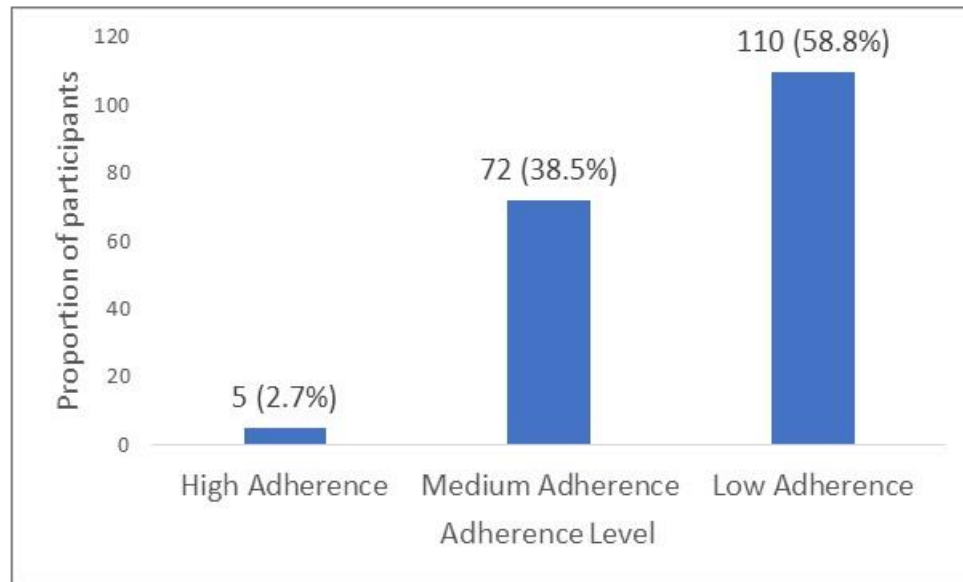


Figure 2: Prevalence of adherence among participants

**Table 4: Sociodemographic factors associated with adherence among participants**

| Variables                                  | Adherence level   |            | Test of significance |
|--------------------------------------------|-------------------|------------|----------------------|
|                                            | High/Medium, n(%) | Low, n(%)  |                      |
| Age group (years)                          |                   |            |                      |
| 10-39 (n=105)                              | 4 (41.4)          | 61 (58.1)  | $\chi^2 = 0.052$     |
| ≥40 (n = 82)                               | 33 (40.2)         | 49 (59.8)  | p=0.819              |
| Sex                                        |                   |            |                      |
| Male (n=106)                               | 42 (39.6)         | 64 (60.4)  | $\chi^2 = 0.244$     |
| Female (n=81)                              | 35 (43.2)         | 46 (56.8)  | p=0.621              |
| Marital status                             |                   |            |                      |
| Single (n=55)                              | 25 (45.5)         | 30 (54.5)  | $\chi^2 = 0.589$     |
| Married/separated/divorced/widowed (n=132) | 30 (22.7)         | 102 (77.3) | p=0.443              |
| Type of marriage                           |                   |            |                      |
| Monogamous (n=112)                         | 53 (47.3)         | 59 (52.7)  | $\chi^2 = 4.353$     |
| Polygamous (n=75)                          | 24 (32.0)         | 51 (68.0)  | p=0.037*             |
| Tribe                                      |                   |            |                      |
| Hausa (n=158)                              | 70 (44.3)         | 88 (55.7)  | $\chi^2 = 4.114$     |
| Other tribes (n=29)                        | 7 (24.1)          | 22 (75.9)  | p=0.043*             |
| Education                                  |                   |            |                      |
| Non-formal (n=118)                         | 58 (49.2)         | 60 (50.8)  | $\chi^2 = 8.399$     |
| Formal (n=69)                              | 19 (27.5)         | 50 (72.5)  | p=0.004*             |
| Occupation                                 |                   |            |                      |
| Employed (n=103)                           | 43 (41.7)         | 60 (58.3)  | $\chi^2 = 0.031$     |
| Unemployed (n=84)                          | 34 (40.5)         | 50 (59.5)  | p=0.861              |

$\chi^2$ : Pearson's chi square test; \*Statistically significant (p<0.05)

**Table 5: Psychosocial factors associated with adherence among participants**

| Variables                            | Adherence level   |            | Test of significance        |
|--------------------------------------|-------------------|------------|-----------------------------|
|                                      | High/Medium, n(%) | Low, n(%)  |                             |
| Perceived Social Support from family |                   |            |                             |
| Weak (n=89)                          | 27 (30.3)         | 62 (69.7)  | $\chi^2= 8.238$<br>p=0.004* |
| Strong (n = 98)                      | 50 (51.0)         | 48 (49.0)  |                             |
| Communication with health workers    |                   |            |                             |
| Poor (n=2)                           | 0 (0)             | 2 (100)    | Fe = 1.415<br>p=0.513       |
| Good (n=185)                         | 77 (41.6)         | 108 (58.4) |                             |
| Had mood disorders                   |                   |            |                             |
| No (n=106)                           | 36 (34.0)         | 70 (66.0)  | $\chi^2= 5.258$<br>p=0.022* |
| Yes (n=81)                           | 41 (50.6)         | 40 (49.4)  |                             |
| Had active coping strategies         |                   |            |                             |
| No (n=114)                           | 38 (33.3)         | 76 (66.7)  | $\chi^2= 7.417$<br>p=0.006* |
| Yes (n=73)                           | 39 (53.4)         | 34 (46.6)  |                             |

$\chi^2$ : Pearson's chi square test; Fe: Fisher's exact test; \*Statistically significant (p<0.05)

**Table 6: Predictors of drug adherence among participants**

| Variables                                          | aOR   | 95% CI |       | p-value |
|----------------------------------------------------|-------|--------|-------|---------|
|                                                    |       | Lower  | Upper |         |
| Age group (years)                                  |       |        |       |         |
| (10-39 versus ≥40)                                 | 1.091 | 0.486  | 2.446 | 0.833   |
| Sex                                                |       |        |       |         |
| (Males versus Females)                             | 0.881 | 0.437  | 1.775 | 0.723   |
| Marital status                                     |       |        |       |         |
| (Single versus Married/Separated/Divorced/Widowed) | 1.633 | 0.682  | 3.907 | 0.271   |
| Type of marriage                                   |       |        |       |         |
| (Monogamous versus Polygamous)                     | 2.101 | 0.999  | 4.416 | 0.050   |
| Tribe                                              |       |        |       |         |
| (Hausa versus Other tribes)                        | 1.344 | 0.258  | 6.991 | 0.725   |
| Education                                          |       |        |       |         |
| (Non-formal versus Formal)                         | 2.380 | 1.115  | 5.080 | 0.025   |
| Occupation                                         |       |        |       |         |
| (Employed versus Unemployed)                       | 0.733 | 0.353  | 1.525 | 0.406   |
| Settlement                                         |       |        |       |         |
| (Rural versus Urban)                               | 1.579 | 0.790  | 3.154 | 0.196   |
| Perceived social support from family               |       |        |       |         |
| (Weak versus Strong)                               | 0.453 | 0.232  | 0.882 | 0.020   |
| Mood disorders                                     |       |        |       |         |
| (Yes versus No)                                    | 0.630 | 0.321  | 1.236 | 0.179   |
| Active coping strategies                           |       |        |       |         |
| (Yes versus No)                                    | 1.913 | 0.937  | 3.903 | 0.075   |

aOR: adjusted Odds Ratio, CI: Confidence Interval

No statistically significant differences were observed in the distribution of TB–HIV coinfection across age group, marital status, type of marriage, or occupation. This differs from some reports suggesting that individuals within the productive age group (10–49 years) bear the greatest burden of TB–HIV coinfection.<sup>36</sup>

Regarding treatment adherence, the present study revealed that 58.8% of participants had low adherence to anti-tuberculosis medication, while only a small proportion achieved high adherence. This finding is consistent with reports from other developing countries, including studies conducted in Ethiopia and Uganda.<sup>37,38</sup>



TB–HIV coinfecting patients often face the challenge of managing multiple treatment regimens simultaneously, which may contribute to suboptimal adherence.<sup>21</sup> Poor adherence in such patients can compromise treatment outcomes and increase the risk of disease progression. Several sociodemographic factors were significantly associated with treatment adherence. Participants in monogamous marriages, those belonging to the Hausa ethnic group, and those with non-formal education demonstrated higher adherence to TB treatment.

Psychosocial factors also influenced adherence behavior. In particular, participants with strong perceived family social support were significantly more likely to adhere to treatment. This finding is consistent with evidence from Eritrea demonstrating that family and community support play a critical role in improving adherence to tuberculosis therapy.<sup>39</sup> Overall, the findings highlight the influence of demographic and psychosocial factors on both TB–HIV coinfection and adherence to anti-tuberculosis treatment. Strengthening integrated TB–HIV services and promoting supportive social environments may contribute to improved treatment adherence and better clinical outcomes in similar resource-limited settings.

### STUDY LIMITATIONS

The findings of this study should be interpreted in light of certain limitations. Treatment adherence and related factors were assessed using self-reported data, which may be affected by recall error and social desirability bias, potentially leading to overestimation of adherence or underreporting of undesirable behaviors. In addition, cultural and religious sensitivities within the study setting may have influenced participants' responses, potentially leading to misclassification of adherence behaviors and related factors. Nevertheless, the study offers valuable insights into the prevalence of TB–HIV coinfection and the determinants of treatment adherence among tuberculosis patients in this setting.

### CONCLUSION

This study found a moderate prevalence of TB–HIV coinfection (19.0%) among patients with pulmonary tuberculosis attending the Specialist Hospital, Sokoto. Coinfection was significantly associated with male sex, non-Hausa ethnicity, and urban residence, whereas age, marital status, type of marriage, and occupation were not. Treatment adherence was generally low. Better adherence was independently associated with non-formal education, monogamous marital structure, and strong perceived

family support. These findings highlight the need for strengthened adherence-support strategies and improved integration of TB–HIV services to enhance treatment outcomes in similar settings.

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Nil.

### Conflict of interest

None declared.

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# Awareness and Perception of Health Facility Delivery Among Women of Child-Bearing Age in Jema'a LGA, Kaduna State, Northwestern Nigeria

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## ABSTRACT

**Background:** Maternal mortality remains a major public health challenge in Nigeria, with many deaths occurring during childbirth. Delivery in health facilities with skilled attendants significantly reduces maternal and neonatal complications. However, home delivery remains common in many rural communities due to sociocultural beliefs, poor access to health services, and financial constraints. Evidence on women's awareness and perceptions of health facility delivery (HFD) in Jema'a Local Government Area (LGA) of Kaduna State is limited. **Aim:** To assess the awareness and perception of health facility delivery among women of childbearing age in Jema'a LGA, Kaduna State, Nigeria. **Materials and Methods:** A community-based descriptive cross-sectional study was conducted among 250 women aged 15–49 years who had delivered at least once. A multistage sampling technique was used to select respondents from four wards and their communities. Data were collected using a structured, pretested, interviewer-administered questionnaire and analysed using descriptive statistics with SPSS version 24. **Results:** The mean age of respondents was  $23.4 \pm 7.8$  years. Most were married (88.8%), had a primary education (44.8%), and were engaged in business (42.0%). Awareness of HFD was high (78.0%), mainly through health workers (50.0%). Although 84.4% preferred HFD, home delivery remained common (50.0%). Perceived benefits included availability of medical equipment (36.0%) and skilled attendants (22.0%). Major barriers were distance (36.0%) and cost (22.0%). Spouses/partners influenced delivery decisions in 50.0% of cases. **Conclusion:** Despite high awareness and preference for HFD, sociocultural and access barriers persist. Addressing affordability, accessibility, and male involvement may improve utilization of skilled delivery services.

**Keywords:** Health Facility Delivery, Awareness, Perception, Childbearing women, Kaduna

## INTRODUCTION

Maternal mortality remains a major global public health challenge, particularly in low- and middle-income countries where access to quality maternal healthcare services is limited. Despite notable progress over the past two decades, an estimated 287,000 women still die annually from pregnancy-related causes, with sub-Saharan Africa accounting for the majority of these deaths.<sup>1</sup> Many of these deaths occur during labour and delivery and are largely preventable through timely access to skilled obstetric care. Ensuring that childbirth occurs under the supervision of trained health professionals is therefore critical for improving maternal and neonatal survival. Health facility delivery (HFD) is widely recognized as a key intervention for reducing maternal and neonatal mortality. The World Health Organization (WHO) recommends that all women give birth in health facilities where skilled birth attendants and emergency obstetric

services are available.<sup>2</sup> HFD refers to childbirth within recognized healthcare settings such as hospitals, maternity clinics, or primary healthcare centres, where trained personnel and essential equipment are available to manage normal deliveries and obstetric complications.<sup>3</sup> Facility-based deliveries enable early detection and prompt management of complications such as haemorrhage, sepsis, obstructed labour, and hypertensive disorders, which are among the leading causes of maternal mortality globally.<sup>1</sup>

Despite these benefits, the utilization of health facility delivery services remains uneven, particularly in low-resource settings.<sup>3</sup> Women's decisions regarding place of delivery are influenced by a complex interplay of socioeconomic, cultural, and health system factors, including cost of care, accessibility, transportation,

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sociocultural beliefs, and perceived quality of services.<sup>3,4</sup> In many communities, traditional childbirth practices and reliance on traditional birth attendants continue to influence delivery choices even where health facilities exist.<sup>3</sup> Nigeria contributes substantially to global maternal mortality and has one of the highest maternal mortality ratios worldwide.<sup>4</sup> Although national efforts have sought to strengthen maternal health systems, disparities in utilization persist across regions and socioeconomic groups. Northern Nigeria, in particular, continues to record poorer maternal health indicators compared with southern regions.<sup>5</sup> Factors such as lower female education, poverty, limited health infrastructure, and entrenched sociocultural norms contribute to these disparities.<sup>6</sup>

In Northwestern Nigeria, utilization of skilled birth services is especially low. Cultural practices, financial constraints, and geographic barriers often limit access to health facilities.<sup>6</sup> In addition, decision-making regarding maternal healthcare is frequently influenced by family members, particularly spouses and elders, which may affect women's autonomy in seeking facility-based delivery services. At the health system level, shortages of healthcare workers, inadequate infrastructure, and concerns about the quality of care further reduce utilization.<sup>7</sup> Evidence from national surveys highlights the magnitude of this challenge. The 2018 Nigeria Demographic and Health Survey reported that only 39% of births nationwide occur in health facilities, with substantially lower proportions in Northwestern Nigeria, where only about 17% of births take place in health facilities.<sup>4</sup> This disparity underscores the persistent barriers to skilled care. Several studies indicate that women's perceptions of the benefits and risks associated with facility-based childbirth play a critical role in shaping delivery choices.<sup>8</sup> Women who perceive health facilities as safe and well-equipped are more likely to utilize them, whereas negative perceptions about the quality of care may discourage facility-based delivery.

Perceptions of care within health facilities are increasingly recognized as important determinants of maternal health service utilization. Experiences of disrespect, lack of privacy, and poor provider attitudes during childbirth have been reported as barriers to facility-based delivery.<sup>9</sup> Such experiences may reinforce community preferences for home delivery and reduce trust in health institutions. Conversely, positive perceptions of respectful and competent care may encourage women to seek facility-

based services. Understanding women's perceptions of HFD is therefore essential for designing interventions to improve uptake of skilled delivery services.

In Kaduna State, maternal health services have been strengthened through policy initiatives and strategic health development plans.<sup>7</sup> Nevertheless, disparities in access and utilization remain evident, particularly in rural and semi-urban communities. Structural barriers such as long distances to facilities, limited transportation options, and financial constraints continue to affect women's ability to access skilled delivery services. These challenges are compounded by sociocultural beliefs and traditional childbirth practices that remain embedded within communities. Jema'a Local Government Area (LGA) in Kaduna State exemplifies these contextual realities. The LGA comprises rural and semi-urban communities, where primary healthcare facilities are the main providers of maternal health services.<sup>10</sup>

However, traditional birthing practices remain prevalent, and women's decisions regarding place of delivery are frequently influenced by household dynamics, cultural norms, and perceptions about the benefits or limitations of facility-based childbirth. Although numerous studies have examined determinants of maternal healthcare utilization in Nigeria, limited evidence exists regarding community-level awareness and perceptions of HFD in specific contexts such as Jema'a LGA.<sup>11</sup> Existing research suggests that gaps often exist between awareness of the benefits of facility delivery and actual utilization.<sup>12</sup> In many settings, women may recognize the advantages of skilled birth attendance but still prefer home delivery due to cultural familiarity, perceived convenience, or financial considerations.

These findings highlight the need for localized evidence on how awareness and perceptions influence delivery choices within specific communities. Addressing this gap is essential for informing context-appropriate maternal health interventions. Understanding women's awareness and perceptions of HFD can guide policies and programs aimed at improving utilization of skilled delivery services and reducing maternal and neonatal morbidity and mortality. Therefore, this study aimed to assess the awareness and perception of health facility delivery among women of childbearing age in Jema'a Local Government Area of Kaduna State, Northwestern Nigeria.



## MATERIALS AND METHODS

### Study Design, Population, and Area

This study employed a community-based descriptive cross-sectional design conducted between March and July 2025 in Jema'a Local Government Area (LGA), Kaduna State, Northwestern Nigeria. Jema'a LGA is characterized by heterogeneous ethnic groups and predominantly agrarian livelihoods, with farming as the primary economic activity for residents.<sup>13</sup> The study population comprised women of reproductive age (15–49 years) residing in the selected communities who had experienced at least one previous delivery. Women who were severely ill at the time of the survey or temporarily absent from their households during data collection were excluded from the study.

### Sample Size Estimation and Sampling Technique

The minimum sample size was estimated at 277 using the Cochran formula for a single proportion,<sup>14</sup> based on a 23.6% prevalence of awareness of health facility delivery from a previous study,<sup>15</sup> a 5% margin of error, and a 90% response rate. A multistage sampling technique was used to select participants. In the first stage, four wards (Jagindi, Takau, Maigizo, and Asso) were selected by simple random sampling from the twelve wards in Jema'a LGA. In the second stage, one community was randomly selected from each of the chosen wards. In the third stage, households were systematically selected until the required sample size for each community was reached. Within each selected household, eligible women were identified, and one respondent was chosen using simple random sampling by balloting where more than one eligible participant was present, thereby minimizing potential selection bias.

### Data Collection

Data were collected using a structured, interviewer-administered questionnaire developed following a review of the relevant literature on maternal health service utilization and perceptions of facility-based delivery. The questionnaire was pre-tested among 30 women in a neighbouring community with similar socio-demographic characteristics but not included in the main study. The pre-test assessed the instrument's clarity, relevance, sequencing, and average completion time, and necessary adjustments were made accordingly. Content validity of the questionnaire was ensured through expert review by two public health specialists, and the internal consistency of perception-related items was assessed using

Cronbach's alpha, yielding a reliability coefficient of 0.71, indicating acceptable reliability. The final questionnaire comprised sections on socio-demographic characteristics, awareness of health facility delivery, and perceptions toward facility-based childbirth.

### Data Analysis

Collected data were checked for completeness and entered into Statistical Package for the Social Sciences (SPSS) version 24.0 for analysis. Descriptive statistics were used to summarize the data. Categorical variables were presented as frequencies and percentages, while continuous variables, such as age, were summarized using means and standard deviations. Results were presented using texts and tables where appropriate to facilitate interpretation.

### Ethical Consideration

Ethical approval for the study was obtained from the Kaduna State Ministry of Health Research Ethics Committee prior to the commencement of data collection. Permission for community entry was also obtained from local administrative and community leaders within the study area. Participants were informed about the objectives, procedures, and voluntary nature of the study, and the confidentiality of the information provided was strictly maintained. No personal identifiers were included in the dataset, and participants were assured that the information collected would be used solely for research purposes. Written informed consent was obtained from all adult participants. For respondents under 18 years of age, assent was obtained from the participant and consent from a parent or guardian.

## RESULTS

### Respondents' sociodemographic characteristics

A total of 250 women of reproductive age participated in the study. The respondents' ages ranged from 15 to 49 years, with a mean age of  $23.4 \pm 7.8$  years. The majority of participants were 15–20 years old (150, 60.0%). Most respondents were married (222, 88.8%). Regarding educational attainment, primary education was the most common level achieved (112, 44.8%), while 105 (42.0%) of the respondents were engaged in business-related activities as their main occupation. Regarding parity, 125 respondents (50.0%) reported having five or more children [Table 1].

**Table 1: Respondents' socio-demographic characteristics**

| Variables                           | Frequency (%) n = 250 |
|-------------------------------------|-----------------------|
| Age group (years)                   |                       |
| 15-20                               | 150 (60.0)            |
| 21-30                               | 48 (19.2)             |
| 31-40                               | 25 (10.0)             |
| 41-49                               | 27 (10.8)             |
| Marital status                      |                       |
| Single                              | 2 (0.8)               |
| Married                             | 222 (88.8)            |
| Divorced                            | 12 (4.8)              |
| Widowed                             | 14 (5.6)              |
| Level of education                  |                       |
| No formal education                 | 55 (22.0)             |
| Primary                             | 112 (44.8)            |
| Secondary                           | 75 (30.0)             |
| Tertiary                            | 8 (3.2)               |
| Occupation                          |                       |
| Business/Trading                    | 105 (42.0)            |
| Farming                             | 57 (22.8)             |
| Civil Servant                       | 55 (22.0)             |
| Others (artisans, homemakers, etc.) | 33 (13.2)             |
| Number of children                  |                       |
| 1                                   | 59 (23.6)             |
| 2                                   | 11 (4.4)              |
| 3                                   | 55 (22.0)             |
| 4                                   | 0 (0)                 |
| 5                                   | 125 (50)              |

### Awareness of health facility delivery among respondents

Overall, 195 respondents (78.0%) reported being aware of health facility delivery (HFD). Among those aware, health workers were the primary source of information, accounting for 50.0% of responses. Similarly, 195 respondents (78.0%) reported knowing the location of the nearest health facility, while 222 respondents (88.8%) were aware of the benefits of delivering in a health facility [Table 2].

### Respondents' perception of factors influencing delivery choices

Most respondents (201, 80.4%) perceived health facility delivery to be safer than home delivery. The most frequently reported perceived advantages of facility-based delivery included the availability of medical equipment (90, 36.0%) and the presence of skilled birth attendants (55, 22.0%). Conversely, the most commonly perceived barriers to utilizing health facilities for childbirth were the long distance to health facilities (90, 36.0%) and the high cost of services (55, 22.0%). Despite these perceived barriers, a large proportion of respondents (211, 84.4%)

preferred delivery at a health facility. However, home delivery remained a prevalent cultural practice, with 125 respondents (50.0%) reporting it. In addition, 125 respondents (50.0%) identified spouses as the primary decision-makers regarding place of delivery, highlighting the significant role of household dynamics in shaping childbirth choices [Table 3].

**Table 2: Awareness of health facility delivery among respondents**

| Variables                                  | Frequency (%) n = 250 |
|--------------------------------------------|-----------------------|
| Heard about health facility delivery       |                       |
| Yes                                        | 195 (78.0)            |
| No                                         | 55 (22.0)             |
| Source of information*                     |                       |
| Health workers                             | 125 (50.0)            |
| Family/Friends                             | 55 (22.0)             |
| Community meetings                         | 11 (4.4)              |
| Others (radio, church, mosque, etc.)       | 59 (23.6)             |
| Knows the nearest health facility          |                       |
| Yes                                        | 195 (78.0)            |
| No                                         | 55 (22.0)             |
| Aware of health facility delivery benefits |                       |
| Yes                                        | 222 (88.8)            |
| No                                         | 28 (11.2)             |

\*Multiple responses allowed

## DISCUSSION

This study assessed the awareness and perceptions of health facility delivery (HFD) among women of childbearing age in the Jema'a Local Government Area of Kaduna State and revealed an important pattern: although awareness and preference for facility-based childbirth were relatively high, home delivery remains a common cultural practice. This finding highlights a persistent gap between knowledge and actual utilization of skilled birth services, a phenomenon widely reported in maternal health research in low- and middle-income countries.

The relatively high level of awareness of health facility delivery (78.0%) and the even higher proportion of respondents who recognized its benefits (88.8%) suggest that maternal health information is reaching a substantial proportion of women in the study area. Similar findings have been reported in other parts of Northern Nigeria, where expanded maternal health education and antenatal counseling have improved women's knowledge of safe delivery practices.<sup>16,17</sup>

**Table 3: Respondents' perception of factors influencing delivery choices**

| Variables                                   | Frequency (%)<br>n = 250 |
|---------------------------------------------|--------------------------|
| Believes health facility delivery is safer  |                          |
| Yes                                         | 201 (80.4)               |
| No                                          | 49 (19.6)                |
| Perceived advantages*                       |                          |
| Medical equipment available                 | 90 (36.0)                |
| Skilled birth attendant present             | 55 (22.0)                |
| Access to emergency care                    | 35 (14.0)                |
| Better hygiene                              | 35 (14.0)                |
| Others (e.g., pain relief)                  | 35 (14.0)                |
| Perceived disadvantages*                    |                          |
| Far distance to the facility                | 90 (36.0)                |
| High cost of services                       | 55 (22.0)                |
| Negative attitude of staff                  | 35 (14.0)                |
| Cultural reasons/preference                 | 35 (14.0)                |
| Others (e.g., lack of transport)            | 35 (14.0)                |
| Prefer a health facility for delivery       |                          |
| Yes                                         | 211 (84.4)               |
| No                                          | 39 (15.6)                |
| Common cultural practices in the community* |                          |
| Home delivery                               | 125 (50.0)               |
| Delivery by a traditional birth attendant   | 55 (22.0)                |
| Postpartum confinement at home              | 35 (14.0)                |
| Others                                      | 35 (14.0)                |
| Spousal role in decision                    |                          |
| Major role                                  | 125 (50.0)               |
| Minor role                                  | 55 (22.0)                |
| No role                                     | 70 (28.0)                |

\*Multiple responses allowed

Increased awareness in such settings is often attributed to sustained community health education programs and antenatal care outreach initiatives aimed at improving maternal health outcomes.<sup>16</sup> The finding that health workers constituted the primary source of information further emphasizes their critical role as trusted providers of maternal health information and agents of behavioral change. Evidence from other settings in sub-Saharan Africa indicates that effective antenatal counseling and the use of structured educational tools by health workers significantly improve maternal knowledge regarding childbirth practices and newborn care.<sup>18</sup> Strengthening the capacity of frontline health workers to deliver consistent maternal health messaging may therefore further enhance awareness and influence delivery choices in rural communities.

Despite these encouraging levels of awareness, the study identified several barriers that may limit the translation of knowledge into actual utilization of facility-based delivery services. The perception of long distance to health

facilities (36.0%) as the most common disadvantage reflects persistent geographical access challenges. This finding is consistent with a large body of literature demonstrating that physical distance and transportation difficulties significantly reduce the likelihood of facility-based childbirth in rural areas of sub-Saharan Africa.<sup>19,20</sup> When women must travel long distances to reach obstetric care, delays in accessing skilled services become more likely, particularly during labour when mobility may be limited.<sup>21</sup> Geographic barriers often interact with financial constraints, as the cost of transportation and healthcare services can further discourage facility utilization among economically vulnerable households.

Another notable barrier identified in this study was the perceived high cost of delivery services, reported by 22.0% of respondents. Financial constraints have consistently been identified as a major determinant of maternal healthcare utilization in Nigeria and other low-resource settings.<sup>17</sup> Out-of-pocket payments for healthcare, combined with indirect costs such as transportation and loss of income, can discourage women from seeking skilled birth services even when they are aware of the benefits. Policies aimed at reducing financial barriers, such as subsidized maternal services or community-based health insurance schemes, may therefore play an important role in improving uptake of facility-based delivery.

The persistence of home delivery as a cultural norm (50.0%) despite high awareness of the benefits of facility delivery underscores the influence of sociocultural factors in shaping childbirth practices. Cultural familiarity, comfort within the home environment, and longstanding community traditions often reinforce preferences for home delivery, particularly in rural settings. Similar findings have been reported in studies conducted in Ethiopia and Nigeria, where women frequently prioritize cultural expectations and personal comfort over biomedical recommendations regarding childbirth location.<sup>22,23</sup> These findings suggest that knowledge alone may be insufficient to change entrenched behavioural patterns. Effective interventions must therefore address cultural beliefs and social norms through community-based engagement strategies, including dialogue with traditional leaders, community influencers, and women's groups.

Interestingly, the finding that a substantial proportion of respondents reported not being actively advised by family members to deliver at home suggests that the persistence of home delivery may not necessarily be driven by explicit family pressure but rather by internalized cultural norms and habitual practices within the community. This observation presents an important opportunity for maternal health programs: if community members are not strongly opposed to facility delivery, targeted behavior-change communication and community education initiatives could gradually shift perceptions and normalize facility-based childbirth.

Another important finding from this study is the significant role of spouses in decision-making regarding place of delivery, with half of the respondents identifying their husbands as key decision-makers. Male involvement in maternal health has been widely recognized as an important determinant of women's utilization of maternal healthcare services in sub-Saharan Africa.<sup>24</sup> In many patriarchal societies, men control household resources and make critical decisions related to healthcare utilization. Consequently, maternal health programs that focus exclusively on women may overlook an important determinant of service uptake. Encouraging male participation in maternal health education, antenatal care visits, and community discussions on safe motherhood may therefore enhance support for facility-based delivery and improve maternal health outcomes.

Overall, the findings of this study highlight that while awareness of health facility delivery is relatively high in Jema'a LGA, structural barriers, sociocultural norms, and household decision-making dynamics continue to influence childbirth practices. Addressing these multifaceted challenges will require integrated strategies that combine improved health system accessibility, community engagement, and male involvement in maternal health interventions to promote safer childbirth practices and reduce preventable maternal and neonatal morbidity and mortality.

## STUDY LIMITATIONS

Several limitations should be considered when interpreting the findings of this study. The cross-sectional design limits the ability to establish causal relationships between awareness, perceptions, and the utilization of health facility delivery services. In addition, the study relied on self-reported data, which may be subject to recall

and social desirability biases, particularly given that interviews were conducted face-to-face. The study was also conducted in a single Local Government Area (Jema'a LGA) in Kaduna State, which may limit the generalizability of the findings to other regions with different sociocultural and health system contexts. Furthermore, the structured questionnaire primarily captured quantitative data, limiting deeper exploration of sociocultural factors influencing delivery choices. Qualitative approaches such as focus group discussions or in-depth interviews could provide richer insights into these dynamics. Despite these limitations, the study provides useful evidence on awareness and perceptions of health facility delivery among women of reproductive age in Jema'a LGA, which may help inform context-specific maternal health interventions to improve the utilization of skilled birth services.

## CONCLUSION

This study found that awareness and positive perceptions of health facility delivery (HFD) are high among women in Jema'a LGA, Kaduna State; however, home delivery remains common, indicating a gap between knowledge and practice. Key barriers include distance to health facilities, perceived service costs, cultural norms, and spouses' influence on delivery decisions. Improving HFD utilization requires integrated interventions that enhance physical and financial access to maternal healthcare, strengthen service quality, and promote community engagement and male involvement to advance maternal health and Sustainable Development Goal targets.

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## Source of support

Nil.

## Conflict of interest

None declared.



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# Occupational Health Knowledge, Attitudes, Safety Practices, and Associated Factors among Automobile Mechanics in Ikeja Local Government Area, Lagos State, Nigeria

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## ABSTRACT

**Background:** Occupational hazards remain a major global public health concern, with a disproportionate burden in the informal sector of low- and middle-income countries. Automobile mechanics are frequently exposed to multiple workplace hazards, yet gaps persist between knowledge and safe practices. **Aim:** To assess occupational health knowledge, attitudes, safety practices, and associated factors among automobile mechanics in Ikeja Local Government Area, Lagos State, Nigeria. **Materials and Methods:** A cross-sectional study was conducted among 196 automobile mechanics selected using a multistage sampling technique. Data were collected using an interviewer-administered structured questionnaire covering sociodemographic characteristics, knowledge, attitudes, and safety practices. Data were analyzed using Epi Info (version 2017). Descriptive statistics were computed, and associations were tested using the chi-square test at a significance level of  $p < 0.05$ . **Results:** The mean age of respondents was  $31.66 \pm 12.6$  years, with the majority being male (99.0%) and Yoruba (82.5%). Most respondents demonstrated good knowledge of occupational hazards (82.7%) and positive attitudes toward safety practices (68.9%). High awareness was observed regarding risks such as exposure to harmful substances (88.8%), inhalation of exhaust fumes (95.4%), and manual lifting injuries (92.3%). However, only 48.0% exhibited good safety practices. While 70.9% reported regular workplace cleaning and 56.1% practiced hand hygiene, the use of personal protective equipment was inconsistent. Ethnic group was significantly associated with knowledge of occupational hazards ( $p = 0.01$ ), whereas other sociodemographic factors were not. **Conclusion:** Although knowledge and attitudes toward occupational hazards were generally good, safety practices among automobile mechanics were suboptimal. Targeted interventions focusing on behavioral change, improved access to protective equipment, and strengthened occupational health policies are recommended.

**Keywords:** Occupational health knowledge, Attitudes toward safety, Safety practices, Automobile mechanics, Personal protective equipment (PPE)

## INTRODUCTION

Occupational health and safety (OHS) remains a critical public health and development concern worldwide, particularly in labor-intensive sectors. Recent global estimates indicate that approximately 2.9 million deaths are attributable to work-related causes annually, with 2.58 million resulting from occupational diseases and about 0.32 million from occupational injuries.<sup>1</sup> These figures underscore the substantial burden of occupational risks and the urgent need for effective preventive strategies. Even in high-income countries with relatively advanced regulatory systems, occupational hazards persist. For instance, in the United States, about 3.9 per 100 full-time workers in the automobile repair and maintenance sector experience non-fatal occupational injuries or illnesses annually.<sup>2</sup> This highlights the inherently hazardous nature of automobile repair work, irrespective of setting.

In low- and middle-income countries such as Nigeria, the situation is further complicated by the predominance of the informal sector, where occupational health issues are often under-recognized and poorly addressed. Roadside automobile mechanics constitute a significant segment of this informal workforce, yet their occupational health needs remain inadequately documented.<sup>3</sup> The lack of structured occupational health services for this group exacerbates their vulnerability, as coverage is minimal or entirely absent.<sup>4</sup> Consequently, these workers are frequently exposed to a wide range of physical, chemical, and ergonomic hazards without adequate protection or awareness.

Empirical evidence from Nigeria presents a mixed picture regarding automobile mechanics' knowledge and attitudes

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toward occupational hazards. Some studies have reported moderate to good levels of knowledge and generally positive attitudes toward workplace safety among mechanics.<sup>5-8</sup> These findings suggest a degree of awareness that could serve as a foundation for improved safety behaviors. However, other studies have demonstrated gaps in knowledge, particularly concerning specific safety practices and risk mitigation measures.<sup>9-12</sup> This inconsistency points to disparities in training, education, and access to occupational health information across different settings.

The broader context of OHS in developing countries further compounds these challenges. While formal sectors may have regulatory frameworks in place, enforcement and compliance are often weak. In contrast, the informal sector, where most automobile mechanics operate, faces significant deficits in regulation, monitoring, and institutional support.<sup>13</sup> This lack of oversight contributes to poor safety culture and limited adoption of preventive measures. As a result, many mechanics may not fully understand the hazardous nature of the substances they handle, including fuels, lubricants, solvents, and heavy metals, nor the long-term health implications of exposure. Risky occupational practices are commonly observed among automobile mechanics and reflect both knowledge gaps and entrenched work habits. These include sucking fuel by mouth, loosening bolts with bare hands, and using petrol or diesel to clean hands.<sup>4,11,12</sup>

Such practices increase the risk of acute and chronic health effects, including chemical poisoning, dermatitis, and respiratory conditions. Despite these risks, the use of personal protective equipment (PPE) remains inconsistent. Studies have shown variability in PPE utilization across regions, with overalls being the most commonly used protective gear, while other essential items, such as gloves, goggles, and masks, are less frequently adopted.<sup>11,12</sup> This pattern suggests partial compliance and highlights the need for comprehensive safety interventions.

Several factors have been identified as influencing safety practices among automobile mechanics. These include sociodemographic and occupational characteristics such as age, educational level, type and duration of training, working hours, and years of experience.<sup>6,12,13</sup> Generally, older and more experienced workers, as well as those with higher educational attainment or formal training, are more likely to demonstrate better safety practices. However, the

persistence of unsafe behaviors despite awareness of occupational hazards indicates a critical gap between knowledge and practice.<sup>12</sup> This disconnect may be attributed to factors such as economic constraints, limited access to PPE, perceived inconvenience, or lack of enforcement of safety standards.

Given these challenges, there is a pressing need for context-specific research to better understand the dynamics of occupational health knowledge, attitudes, and practices among automobile mechanics, particularly in urban informal settings. Ikeja Local Government Area in Lagos State is a major hub for automobile repair, with a high concentration of roadside mechanics operating under diverse conditions. Assessing their level of knowledge, attitudes toward occupational risks, and safety practices, as well as identifying associated factors, is essential for informing targeted interventions and policy development. Therefore, this study aimed to evaluate the occupational health knowledge, attitudes, safety practices, and associated factors among automobile mechanics in Ikeja Local Government Area, Lagos State, Nigeria. By generating evidence in this context, the study seeks to contribute to developing effective strategies to improve workplace safety and reduce the burden of occupational hazards among this underserved population.

## **MATERIALS AND METHODS**

### **Study Design, Population, and Area**

This study employed a cross-sectional design to assess occupational health knowledge, attitudes, safety practices, and associated factors among automobile mechanics in Ikeja Local Government Area (LGA), Lagos State, Nigeria. Eligible participants included general automobile mechanics, diesel mechanics, brake and transmission technicians, auto body repairers, service technicians, automobile welders, auto glass technicians, and tyre repairers. All automobile mechanics who were actively engaged in practice within the selected study sites and who provided informed consent were considered eligible and enrolled in the study.

### **Sample Size Estimation and Sampling Technique**

The minimum sample size for the study was estimated at 196 using Cochran's formula for a single proportion,<sup>14</sup> based on an 86% prevalence of positive safety practices regarding occupational hazards from a previous study,<sup>15</sup> and an anticipated 90% response rate. A multistage sampling technique was employed to select study

participants. In the first stage, five wards were selected from the ten wards in Ikeja LGA using a simple random sampling technique (balloting). In the second stage, three automobile mechanic workshops were selected from each of the selected wards by simple random sampling. In the third stage, two groups of mechanics were selected from each workshop using a simple random technique. In the final stage, eligible automobile mechanics within each selected group were recruited via simple random sampling. Only respondents who met the inclusion criteria and consented to participate were enrolled in the study.

### Data Collection

Data were collected using an interviewer-administered structured questionnaire adapted from a previous similar study.<sup>7</sup> The instrument was designed to obtain information on respondents' sociodemographic characteristics, knowledge of occupational hazards, attitudes toward work-related hazards and safety practices, prevalence of occupational injuries, and safety practices among automobile mechanics. The questionnaire consisted of five sections: Section A captured sociodemographic information; Section B assessed knowledge of occupational hazards; Section C evaluated attitudes toward occupational hazards and safety practices; Section D assessed the prevalence of occupational injuries; and Section E assessed safety practices. The instrument was reviewed for content validity by experts in public health and occupational health. Three research assistants, who were medical students, were recruited and trained for 2 days on the study's objectives, ethical considerations, and questionnaire administration. Data collection was conducted through face-to-face interviews, with each interview lasting approximately 15 minutes. Completed questionnaires were checked on-site for completeness and consistency by the research assistants and the principal investigator to ensure data quality.

### Data Analysis

Data were entered and analyzed using Epi Info statistical software (version 2017). Quantitative variables were summarized using means and standard deviations, while categorical variables were summarized using frequencies and percentages. Results were presented using tables and charts. Knowledge of occupational hazards was assessed by assigning 1 point for each correct response and 0 for each incorrect response. Respondents who scored  $\geq 50\%$  were categorized as having good knowledge, while those

who scored  $< 50\%$  were categorized as having poor knowledge. Attitude toward occupational hazards and safety practices was assessed using a 5-point Likert scale; respondents with scores  $\geq 50\%$  were classified as having a positive attitude, and those with scores  $< 50\%$  were classified as having a negative attitude.<sup>15</sup> Inferential statistics were conducted using the Chi-square test to assess associations between categorical variables. The level of statistical significance was set at  $p < 0.05$ .

### Ethical Consideration

Ethical approval for the study was obtained from the Health Research Ethics Committee of Lagos State University Teaching Hospital. Permission to enter the study sites and to administer the questionnaire was obtained from the leadership of the automobile mechanics' association in Ikeja LGA. The purpose of the study was explained to all participants, and informed consent was obtained prior to data collection. Participation was voluntary, and respondents were assured of the confidentiality of the information provided. All data collected was used strictly for research purposes and was handled with strict confidentiality.

## RESULTS

### Sociodemographic characteristics of respondents

A total of 196 questionnaires were completed and analyzed, yielding a 100% response rate. More than half of the respondents (55.6%) were aged less than 30 years, with a mean age of  $31.66 \pm 12.6$  years. The vast majority were male (99.0%), and most were Yoruba (82.5%). Slightly over half (53.6%) were single, while 48.5% had attained secondary education. Most respondents (73.0%) were employed full-time, and 38.3% had 1–4 years of work experience [Table 1].

### Respondents' knowledge of occupational hazards

The majority of respondents demonstrated awareness of occupational hazards. Most (95.4%) knew that injuries or diseases could result from workplace hazards, and 88.8% recognized that working without personal protective equipment (PPE) could expose workers to harmful substances. Similarly, 95.4% reported that eating with unwashed hands was harmful, while 87.2% identified sucking fuel by mouth as dangerous. Three-quarters (75.0%) were aware that washing hands with fuel or engine oil was hazardous. In addition, 95.4% acknowledged the harmful effects of inhaling exhaust fumes, 81.6% identified noise exposure as a cause of

hearing loss, 92.3% recognized manual lifting as a cause of low back pain, and 91.8% were aware of the risk of eye injury from spray painting [Table 2].

**Table 1: Sociodemographic characteristics of respondents**

| Variables                  | Frequency (%) n = 196 |
|----------------------------|-----------------------|
| Age group (years)          |                       |
| ≤30                        | 109 (55.6)            |
| 31-40                      | 40 (20.4)             |
| 41-50                      | 24 (12.2)             |
| ≥51                        | 23 (11.8)             |
| Mean = 31.66 ± 12.6        |                       |
| Gender                     |                       |
| Male                       | 194 (99.0)            |
| Female                     | 2 (1.0)               |
| Ethnic group               |                       |
| Yoruba                     | 162 (82.5)            |
| Igbo                       | 29 (14.8)             |
| Hausa                      | 5 (2.5)               |
| Marital status             |                       |
| Single                     | 105 (53.6)            |
| Married                    | 74 (37.8)             |
| Separated                  | 8 (4.1)               |
| Widowed                    | 9 (4.5)               |
| Religion                   |                       |
| Christianity               | 106 (54.1)            |
| Islam                      | 90 (45.9)             |
| Level of education         |                       |
| No formal education        | 1 (0.5)               |
| Primary                    | 21 (10.7)             |
| Secondary                  | 95 (48.5)             |
| Tertiary                   | 79 (40.3)             |
| Nature of the job          |                       |
| Full-time                  | 143 (73.0)            |
| Part-time                  | 53 (27.0)             |
| Length of practice (years) |                       |
| ≤1                         | 21 (10.7)             |
| 1-4                        | 75 (38.3)             |
| 5-9                        | 52 (26.5)             |
| ≥10                        | 48 (24.5)             |

#### Association between respondents' sociodemographic characteristics and knowledge of occupational hazards

There was a statistically significant association between ethnic group and overall knowledge of occupational hazards ( $\chi^2 = 9.331$ ,  $p = 0.01$ ). A higher proportion of respondents from the Yoruba ethnic group (86.4%) had good knowledge compared to those from the Igbo (65.5%) and Hausa (60.0%) ethnic groups. No statistically significant associations were observed between knowledge of occupational hazards and age, gender, marital status, religion, or level of education ( $p > 0.05$ ) [Table 3].

**Table 2: Respondents' knowledge of occupational hazards**

| Variables                                                                                 | Frequency (%) n = 196 |
|-------------------------------------------------------------------------------------------|-----------------------|
| Knew that injuries or diseases could occur due to work                                    |                       |
| Yes                                                                                       | 187 (95.4)            |
| No                                                                                        | 9 (4.6)               |
| Knew that working without personal protective equipment exposes one to harmful substances |                       |
| Yes                                                                                       | 174 (88.8)            |
| No                                                                                        | 22 (11.2)             |
| Knew that eating with unwashed, dirty hands in the workshop is harmful to health          |                       |
| Yes                                                                                       | 187 (95.4)            |
| No                                                                                        | 9 (4.6)               |
| Knew that sucking fuel with the mouth is harmful                                          |                       |
| Yes                                                                                       | 171 (87.2)            |
| No                                                                                        | 25 (12.8)             |
| Knew that washing hands with fuel or engine oil is dangerous                              |                       |
| Yes                                                                                       | 147 (75.0)            |
| No                                                                                        | 49 (25.0)             |
| Knew that inhaling exhaust fumes is hazardous                                             |                       |
| Yes                                                                                       | 187 (95.4)            |
| No                                                                                        | 9 (4.6)               |
| Knew that a noisy hearing environment can cause hearing loss                              |                       |
| Yes                                                                                       | 160 (81.6)            |
| No                                                                                        | 36 (18.4)             |
| Knew that lifting heavy objects manually could cause low back pain                        |                       |
| Yes                                                                                       | 181 (92.3)            |
| No                                                                                        | 15 (7.7)              |
| Knew that tightening bolts with bare hands could cause injury to the fingers              |                       |
| Yes                                                                                       | 169 (86.2)            |
| No                                                                                        | 28 (13.8)             |
| Knew that injury to the eyes could occur from spray painting                              |                       |
| Yes                                                                                       | 180 (91.8)            |
| No                                                                                        | 16 (8.2)              |

#### Respondents' attitudes towards occupational hazards and safety practices

Regarding attitudes, 31.6% of respondents strongly agreed that their work was risky and hazardous, while 39.3% strongly agreed that observing precautionary measures during work was important. The use of personal protective equipment varied: 38.3% strongly agreed to wearing overalls, 30.1% to wearing gloves, 30.6% to wearing eye goggles, and 29.1% to wearing face masks while working. However, a substantial proportion of respondents expressed neutral or less favorable attitudes toward the consistent use of PPE [Table 4].

### Respondents' safety practices towards occupational hazards

Regarding safety practices, 70.9% of respondents reported always cleaning their work environment, and 56.1% reported always washing their hands with soap and water after work. However, PPE utilization was suboptimal, with 50.0% reporting occasional use of gloves, 47.4% reporting safety boots, and 49.0% reporting overalls. Additionally, 48.5% sometimes used a log to support a jack while working, and 42.9% reported using fuel siphon pumps for fuel transfer [Figure 1].

### Respondents' overall knowledge, attitude, and safety practices

Overall, 82.7% of respondents had good knowledge of occupational hazards, while 68.9% demonstrated a positive attitude toward occupational hazards and safety practices. In contrast, less than half (48.0%) exhibited good safety practices [Figure 2].

**Table 3: Association between respondents' sociodemographic characteristics and knowledge of occupational hazards**

| Variables                          | Overall knowledge |           | Test of significance         |
|------------------------------------|-------------------|-----------|------------------------------|
|                                    | Good, n(%)        | Poor n(%) |                              |
| Age group (years)                  |                   |           |                              |
| ≤30 (n=109)                        | 91 (83.5)         | 18 (16.5) | $\chi^2 = 0.719$<br>p=0.86   |
| 31-40 (n=40)                       | 34 (85.0)         | 6 (15.0)  |                              |
| 41-50 (n=24)                       | 19 (79.2)         | 5 (20.8)  |                              |
| ≥51 (n=23)                         | 18 (78.3)         | 5 (21.7)  |                              |
| Gender                             |                   |           |                              |
| Male (n=194)                       | 160 (98.8)        | 34 (17.5) | Fe = 0.424<br>p=0.51         |
| Female (n=2)                       | 2 (100)           | 0 (0)     |                              |
| Ethnic group                       |                   |           |                              |
| Yoruba (n=162)                     | 140 (86.4)        | 22 (13.6) | $\chi^2 = 9.331$<br>p=0.010* |
| Igbo (n=29)                        | 19 (65.5)         | 0 (34.5)  |                              |
| Hausa (n=5)                        | 3 (60.0)          | 2 (40.0)  |                              |
| Marital status                     |                   |           |                              |
| Single (n=105)                     | 88 (83.8)         | 17 (16.2) | $\chi^2 = 0.914$<br>p=0.820  |
| Married (n=74)                     | 59 (79.7)         | 15 (20.3) |                              |
| Separated (n=8)                    | 7 (87.5)          | 1 (12.5)  |                              |
| Widowed (n=9)                      | 8 (88.9)          | 1 (11.1)  |                              |
| Religion                           |                   |           |                              |
| Christianity (n=106)               | 88 (83.0)         | 18 (17.0) | $\chi^2 = 0.021$<br>p=0.880  |
| Islam (n=90)                       | 74 (82.2)         | 16 (17.8) |                              |
| Level of education                 |                   |           |                              |
| No formal education/Primary (n=22) | 18 (81.8)         | 4 (18.2)  | $\chi^2 = 2.100$<br>p=0.550  |
| Secondary (n=95)                   | 82 (86.3)         | 13 (13.7) |                              |
| Tertiary (n=79)                    | 62 (78.5)         | 17 (21.5) |                              |

$\chi^2$ : Pearson's chi square test; Fe: Fisher's exact test; \*Statistically significant (p<0.05)

## DISCUSSION

This study assessed occupational health knowledge, attitudes, safety practices, and associated factors among automobile mechanics in Ikeja LGA, Lagos State. The findings provide important insights into the occupational health profile of this largely informal workforce. The respondents were predominantly young and male, reflecting the gendered nature of automobile repair work in Nigeria. This is consistent with findings from studies conducted in Anambra State, Abuja, and Lagos, where the profession was similarly male-dominated.<sup>6,8,17</sup>

About half of the respondents were single, and less than half had attained secondary education. This contrasts with findings among production workers in formal automobile industries, where higher levels of education were reported.<sup>17</sup> The disparity likely reflects differences between formal and informal sectors, particularly in terms of entry requirements and access to structured training.



| Table 4: Respondents' attitudes towards occupational hazards and safety practices |                       |              |                |                 |                          |
|-----------------------------------------------------------------------------------|-----------------------|--------------|----------------|-----------------|--------------------------|
| Variable                                                                          | Strongly Agree, n (%) | Agree, n (%) | Neutral, n (%) | Disagree, n (%) | Strongly Disagree, n (%) |
| Work was risky and hazardous                                                      | 62 (31.6)             | 59 (30.1)    | 34 (17.3)      | 20 (10.2)       | 21 (10.7)                |
| Feared doing work because of hazards                                              | 16 (8.2)              | 7 (3.6)      | 30 (15.3)      | 52 (26.5)       | 91 (46.4)                |
| Considered observing precautionary measures while doing work as important         | 77 (39.3)             | 68 (34.7)    | 35 (17.9)      | 9 (4.6)         | 7 (3.6)                  |
| Wore an overall while working                                                     | 75 (38.3)             | 66 (33.7)    | 38 (19.4)      | 13 (6.6)        | 4 (2.0)                  |
| Wore safety shoes while working                                                   | 52 (27.0)             | 71 (36.2)    | 46 (23.5)      | 18 (9.2)        | 8 (4.1)                  |
| Wore hand gloves while working                                                    | 59 (30.1)             | 58 (29.6)    | 56 (28.6)      | 15 (7.7)        | 8 (4.1)                  |
| Wore eye goggles while working                                                    | 60 (30.6)             | 55 (28.1)    | 59 (30.1)      | 16 (8.2)        | 6 (3.1)                  |
| Wore a face mask while working                                                    | 57 (29.1)             | 44 (22.4)    | 56 (28.6)      | 30 (15.3)       | 9 (4.6)                  |
| Wore a helmet while working                                                       | 51 (26.0)             | 42 (21.4)    | 57 (29.1)      | 31 (15.8)       | 15 (7.7)                 |

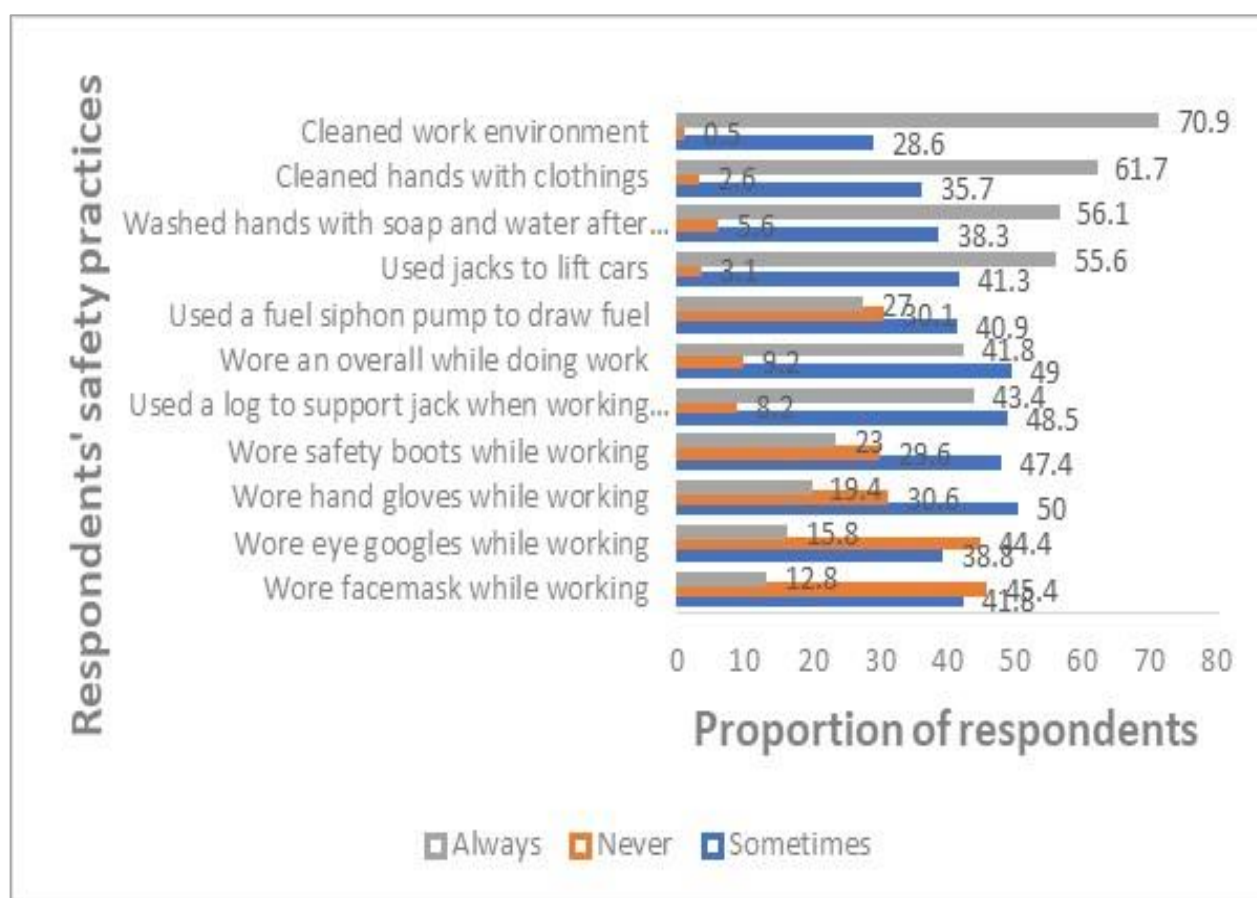
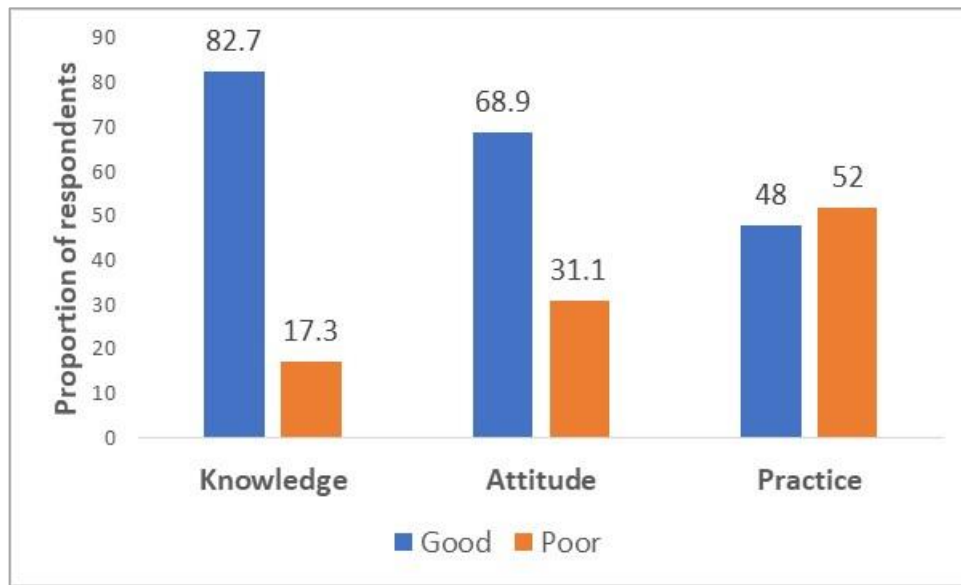


Figure 1: Respondents' safety practices towards occupational hazards



**Figure 2: Respondents' overall knowledge, attitude, and safety practices**

The study demonstrated a high level of knowledge of occupational hazards among respondents. A large proportion correctly identified risks associated with lack of personal protective equipment (PPE), poor hygiene practices, exposure to exhaust fumes, manual handling of heavy loads, and unsafe practices such as fuel siphoning. These findings are consistent with studies conducted in Rivers State and other Nigerian settings, where awareness of occupational hazards among automobile mechanics was also relatively high.<sup>4,5</sup> However, the level of awareness observed in this study was higher than that reported in Lokoja, where knowledge of certain hazardous practices, such as sucking fuel by mouth, was comparatively low.<sup>17,18</sup> Similarly, studies from Akure reported only moderate levels of knowledge among automobile mechanics.<sup>19</sup> These differences may be attributed to variations in study populations, educational exposure, urbanization, and access to occupational health information.

Despite the high level of knowledge, attitudes toward occupational hazards and safety practices were less robust. Although the majority of respondents demonstrated an overall positive attitude, only a minority strongly perceived their work as hazardous or consistently endorsed the use of PPE. This suggests a degree of risk normalization, where hazardous conditions are accepted

as part of routine work. Similar findings have been reported in Uyo, where automobile artisans exhibited generally negative attitudes toward occupational safety.<sup>7</sup> In contrast, the proportion of respondents with positive attitudes in this study was higher than that reported in Surulere, Lagos.<sup>6</sup> This variation may be related to differences in sample size, exposure to safety information, or local workplace culture. Nonetheless, the persistence of ambivalent attitudes toward safety underscores the need for interventions that go beyond knowledge dissemination to address perceptions and beliefs about risk.

The findings on safety practices revealed important gaps between knowledge and behavior. Although some positive practices were observed, such as routine cleaning of the work environment and hand hygiene, overall safety practices were suboptimal, with less than half of respondents demonstrating good practices. The use of PPE was inconsistent, with many respondents reporting only occasional use of gloves, safety boots, and overalls. These findings are consistent with previous studies in Lagos and other parts of Nigeria that reported low PPE utilization among automobile mechanics.<sup>6,19</sup> In Ibadan, for example, PPE use was found to be minimal, highlighting a widespread challenge across different

regions.<sup>20</sup> The relatively higher, yet still inadequate, level of PPE use observed in this study may reflect increased awareness but limited translation into sustained practice.

The persistence of unsafe practices despite good knowledge suggests the influence of contextual and behavioral factors. Previous studies have identified barriers such as cost and limited availability of PPE, discomfort during use, time constraints, and weak enforcement of safety regulations as key determinants of poor compliance.<sup>11,12,13</sup> Additionally, the sector's informal nature limits access to occupational health services and regulatory oversight, further exacerbating unsafe practices. These findings highlight the need for multifaceted interventions that combine education with structural support, including improved access to affordable PPE and enforcement of safety standards.

In examining associated factors, this study found a statistically significant relationship between ethnic group and knowledge of occupational hazards, with respondents from the Yoruba ethnic group demonstrating higher levels of knowledge. This may reflect differences in access to information, social networks, or duration of residence within the study area. However, no significant associations were observed between knowledge and other sociodemographic variables, including age, gender, marital status, religion, and level of education. The lack of association with education contrasts with findings from some studies, which reported that higher educational attainment was associated with better knowledge and safety practices.<sup>17,16,21,22</sup> Conversely, other studies, including one conducted in Akure, have reported no significant relationship between education and knowledge of occupational hazards, consistent with the findings of this study.<sup>19</sup> These inconsistencies suggest that factors beyond formal education, such as informal training and peer learning, may play a significant role in shaping occupational health awareness in this population.

Furthermore, this study did not find a significant association between age and safety practices, in contrast to findings among production workers in formal automobile industries, where older workers demonstrated better compliance with safety measures.<sup>17</sup> This difference may be due to the relatively unstructured nature of work in the informal sector, where experience does not necessarily translate into improved safety behavior. Overall, the findings of this study highlight a critical gap between knowledge and practice among automobile

mechanics. While awareness of occupational hazards is relatively high and attitudes are moderately positive, the adoption of safe work practices remains inadequate. Addressing this gap will require targeted interventions that focus on behavioral change, improved access to protective equipment, and strengthened occupational health policies tailored to the informal sector.

## STUDY LIMITATIONS

This study has some limitations. The cross-sectional design limits the ability to establish causal relationships between variables. Data were collected using self-reported measures, which may be subject to recall and social desirability biases. The study focused on automobile mechanics in a single local government area, which may limit the generalizability of the findings to other settings. Additionally, the assessment of safety practices was not supported by direct observational methods, which could have provided more objective measures of compliance.

## CONCLUSION

This study found that automobile mechanics in Ikeja LGA had generally good knowledge and moderately positive attitudes toward occupational hazards; however, safety practices were suboptimal, particularly in the consistent use of personal protective equipment. The observed gap between knowledge and practice highlights the influence of contextual and behavioral factors. There is a need for targeted interventions, including occupational health education, improved access to protective equipment, and strengthened enforcement of safety regulations, to enhance safe work practices in this population.

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Nil.

## Conflict of interest

None declared.

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## Serum Vitamin A Levels in Children with Cerebral Malaria and Uncomplicated Malaria in Sokoto, Nigeria

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### ABSTRACT

**Background:** Malaria remains a leading cause of morbidity and mortality among children in sub-Saharan Africa. Vitamin A plays an important role in immune regulation and antioxidant defense, and its deficiency may influence susceptibility to severe malaria. **Aim:** To determine and compare serum vitamin A levels in children with cerebral malaria and those with uncomplicated malaria in Sokoto, Nigeria, and to assess the relationship between vitamin A status and malaria parasite density. **Materials and Methods:** This comparative cross-sectional study was conducted between June 2018 and March 2019 at Usmanu Danfodiyo University Teaching Hospital, Sokoto. A total of 221 children aged 6 months to 15 years were enrolled, including 111 with cerebral malaria and 110 with uncomplicated malaria. Clinical and socio-demographic data were obtained using a structured proforma. Malaria diagnosis and parasite density were determined by microscopy, and serum vitamin A levels were measured by colorimetric assay. Data were analyzed using SPSS version 23, with statistical significance set at  $p \leq 0.05$ . **Results:** The mean serum vitamin A level was significantly lower in children with cerebral malaria ( $31.0 \pm 17.7 \mu\text{g/dl}$ ) compared with those with uncomplicated malaria ( $39.3 \pm 15.5 \mu\text{g/dl}$ ;  $p = 0.0001$ ). Mean malaria parasite density was markedly higher in cerebral malaria ( $251,855 \pm 120,853$  parasites/ $\mu\text{l}$ ) than in uncomplicated malaria ( $5,602 \pm 4,020$  parasites/ $\mu\text{l}$ ;  $p = 0.0001$ ). Serum vitamin A levels showed a weak but significant negative correlation with parasite density ( $r = -0.253$ ,  $p = 0.0001$ ). Moderate vitamin A deficiency independently predicted hyperparasitaemia. **Conclusion:** Children with cerebral malaria had significantly lower serum vitamin A levels and higher parasite densities than those with uncomplicated malaria, suggesting a possible role of vitamin A status in malaria severity.

**Keywords:** Vitamin A, cerebral malaria, uncomplicated malaria, parasite density, children, Nigeria

### INTRODUCTION

Malaria remains a major global public health problem, with an estimated 3.2 billion people at risk of infection worldwide.<sup>1</sup> In Nigeria, malaria is a leading cause of morbidity and mortality among children under five years of age and imposes substantial economic and social burdens.<sup>2,3</sup> It accounts for approximately 60% of outpatient consultations and 15% of hospital admissions nationwide.<sup>2</sup> In Sokoto, north-western Nigeria, malaria continues to represent a significant paediatric health challenge, with a reported prevalence of 27.3% among children.<sup>4</sup> Hospital-based studies in the region have shown that uncomplicated malaria accounts for up to 45.4% of paediatric outpatient visits,<sup>5</sup> while severe malaria constitutes nearly one-third of admissions to the Emergency Paediatrics Unit (EPU), with cerebral malaria responsible for about 8% of such admissions.<sup>6,7</sup> Micronutrient deficiencies are common among children living in malaria-endemic regions and may influence

susceptibility to infection and disease severity. Vitamin A is an essential micronutrient that plays a critical role in immune competence, epithelial integrity, and antioxidant defense.<sup>8,9</sup> Evidence from several studies indicates that children with malaria often have reduced serum retinol levels compared with healthy controls.<sup>8-11</sup> Furthermore, serum vitamin A concentrations have been shown to correlate inversely with malaria parasite density, suggesting that worsening parasitaemia may be associated with greater depletion of antioxidant micronutrients.<sup>8-12</sup>

Similar observations have been reported in Nigerian populations.<sup>13-17</sup> For example, a study conducted in Sokoto among preschool children with malaria demonstrated significantly lower serum levels of antioxidant vitamins, including vitamin A, compared with controls, with a negative correlation observed between retinol levels, parasitaemia, and packed cell volume.<sup>15</sup>

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Some investigations have also suggested that antioxidant micronutrients may have a protective role in malaria prevention and disease modulation.<sup>16</sup> The mechanisms underlying reduced vitamin A levels in malaria are not fully understood. However, several factors have been proposed, including increased antioxidant utilization during parasite-induced oxidative stress, reduced dietary intake, impaired absorption, increased urinary losses, and diminished plasma transport capacity during acute infection.<sup>11,17</sup> These processes may contribute to depletion of circulating retinol during malaria episodes, particularly in severe disease.

Cerebral malaria represents the most severe neurological manifestation of *Plasmodium falciparum* infection and is associated with high morbidity and mortality. In Sokoto, it accounts for up to 8% of paediatric emergency admissions with a reported case fatality rate of approximately 26%.<sup>7</sup> Similar patterns have been observed elsewhere in Nigeria, where severe malaria accounts for a substantial proportion of paediatric hospitalizations and deaths.<sup>18</sup> Clinically, cerebral malaria is defined as unarousable coma in the presence of *P. falciparum* parasitaemia after exclusion of other causes of encephalopathy, typically characterized by a Glasgow Coma Scale score  $\leq 11$  or Blantyre Coma Scale  $\leq 3$  persisting beyond 30 minutes following a seizure.<sup>19,20</sup> Survivors frequently experience long-term neurological sequelae, with reported rates ranging from 12% to 23.3%.<sup>21-23</sup>

Current malaria control strategies primarily focus on vector control, chemoprophylaxis, early diagnosis and treatment, and vaccine development.<sup>1</sup> Although these approaches have contributed to reductions in malaria burden, significant challenges remain in achieving sustained control in endemic settings.<sup>1</sup> Understanding the potential contribution of micronutrient status, particularly vitamin A, to malaria severity may provide additional insights into disease pathogenesis and complementary approaches to management. Despite substantial evidence demonstrating reduced vitamin A levels in children with malaria compared with uninfected individuals, studies directly comparing vitamin A status between severe forms, such as cerebral malaria, and uncomplicated malaria remain limited.

Therefore, this study aimed to determine and compare serum vitamin A levels in children aged 6 months to 15 years with cerebral malaria and those with uncomplicated

malaria attending Usmanu Danfodiyo University Teaching Hospital, Sokoto, and to evaluate the relationship between serum vitamin A status, malaria parasite density, and selected socio-demographic characteristics.

## MATERIALS AND METHODS

### Study Design, Population, and Area

This was a hospital-based comparative cross-sectional study conducted from June 2018 to March 2019 at the Department of Paediatrics, Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, Nigeria. The study population comprised children aged 6 months to 15 years who presented with malaria. Children diagnosed with cerebral malaria and admitted to the Emergency Paediatrics Unit (EPU) were enrolled as cases, while those presenting with uncomplicated malaria at the Paediatric Outpatient Department (POPD) served as the comparison group. Cerebral malaria was defined as severe *Plasmodium falciparum* malaria presenting with coma (Glasgow Coma Scale  $\leq 11$  or Blantyre Coma Scale  $\leq 3$ ) persisting for  $\geq 30$  minutes after a seizure, with exclusion of other intracranial causes of coma and confirmation of asexual malaria parasites on peripheral blood film.<sup>19,20</sup> Uncomplicated malaria was diagnosed in children with symptoms consistent with malaria but without features of severe disease, and with the presence of asexual malaria parasites on peripheral blood film.

### Sample Size Estimation

The minimum sample size was determined using a standard formula for comparison of two means.<sup>24</sup> Based on previously reported  $0.3\mu\text{mol/l}$  and  $0.15\mu\text{mol/l}$  standard deviation of vitamin A in children with uncomplicated malaria<sup>15</sup> and cerebral malaria,<sup>25</sup> respectively, following which a total of 221 children were recruited, comprising 110 with uncomplicated malaria and 111 children with cerebral malaria.

### Data Collection

Relevant clinical and socio-demographic information was obtained using a structured study proforma. Blood samples were collected for laboratory investigations. Malaria diagnosis, parasite density estimation, and serum vitamin A assay were performed according to standard laboratory guidelines. Serum vitamin A status was categorized as follows: levels of  $20.04\text{--}30.03\mu\text{g/dl}$  were considered marginal vitamin A deficiency, while levels of

10.02–20.03 µg/dl and <10.02 µg/dl were classified as moderate and severe vitamin A deficiency, respectively.<sup>26</sup>

### Data Analysis

Collected data were checked for completeness and entered into Microsoft Excel before analysis using IBM SPSS version 23. Quantitative variables were summarized using means and standard deviations, while categorical variables were expressed as frequencies and percentages. The independent t-test was used to compare mean serum vitamin A levels between children with cerebral malaria and those with uncomplicated malaria, while analysis of variance (ANOVA) was applied where appropriate. Associations between categorical variables were assessed using Pearson's chi-square test or Fisher's exact test. Pearson's correlation analysis was used to determine the relationship between serum vitamin A levels and malaria parasite density. All levels of significance ( $\alpha$ ) were set at  $p < 0.05$ .

### Ethical Consideration

Ethical approval for the study was obtained from the Health Research and Ethics Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto. Written informed consent was obtained from parents or guardians of all participating children prior to enrollment. Assent was also obtained from children aged seven years and above with uncomplicated malaria. Confidentiality of participants' information was maintained throughout the study.

## RESULTS

### Sociodemographic characteristics of participants

A total of 221 children were enrolled in the study, comprising 111 with cerebral malaria and 110 with uncomplicated malaria. The mean age ( $\pm$ SD) of children with cerebral malaria was  $5.08 \pm 3.4$  years (range: 7 months–15 years), while that of children with uncomplicated malaria was  $5.18 \pm 3.57$  years (range: 6 months–15 years). There was no statistically significant difference in mean age between the two groups ( $t = 0.231$ ,  $p = 0.0818$ ). Cerebral malaria occurred most frequently among children under five years of age, followed by those aged 5 to <10 years, while children aged 10–15 years were least affected; however, this age distribution was not statistically significant. The sex distribution was comparable between the two groups, with male-to-female ratios of 1.4:1 and 1.5:1 among children with cerebral

malaria and uncomplicated malaria, respectively. Regarding socioeconomic status, 64 (57.7%) children with cerebral malaria belonged to the lower socioeconomic class, which was significantly higher than the proportion observed among children with uncomplicated malaria ( $\chi^2 = 9.21$ ,  $p = 0.001$ ). Most participants in both groups had normal nutritional status, with 79 (71.2%) children with cerebral malaria and a comparable proportion among those with uncomplicated malaria classified as nutritionally normal [Table 1].

### Serum vitamin A levels across participants' sociodemographic characteristics

The mean serum vitamin A level among children with cerebral malaria was  $31.0 \pm 17.7$  µg/dl (range: 8.4–168.5 µg/dl), which was significantly lower than the mean level observed among children with uncomplicated malaria ( $39.3 \pm 15.5$  µg/dl, range: 21.0–168.0 µg/dl) ( $p = 0.0001$ ). When stratified by sex and age group, mean serum vitamin A levels remained significantly lower in children with cerebral malaria than in those with uncomplicated malaria. However, no statistically significant differences in vitamin A levels were observed within each malaria group across sex or age categories [Table 2].

### Serum vitamin A status according to the severity of malaria among participants

All cases of moderate and severe vitamin A deficiency occurred among children with cerebral malaria, whereas the majority of children with normal vitamin A status were those with uncomplicated malaria. This distribution was statistically significant, suggesting an association between lower vitamin A status and increased malaria severity [Table 3].

### Malaria parasite density by severity of malaria and participants' sociodemographic characteristics

A markedly higher parasite burden was observed among children with cerebral malaria. Hyperparasitaemia ( $>200,000$  parasites/µl) was recorded in 86 (77.5%) children with cerebral malaria, whereas none of the children with uncomplicated malaria had parasite densities exceeding this threshold. This difference was statistically significant ( $p < 0.001$ ). Comparison of mean parasite density across sex and age groups showed significant differences between the cerebral malaria and uncomplicated malaria groups, but no significant variations were observed within each group when stratified by sex or age [Table 4].

### Correlation between serum vitamin A levels and malaria parasite density among participants

A weak but statistically significant negative correlation was observed between serum vitamin A levels and malaria parasite density among the study participants ( $r = -0.253$ ,  $p < 0.001$ ). Increasing parasite density was associated with progressively lower serum vitamin A levels, indicating an inverse relationship between vitamin A status and malaria parasite burden [Figure 1].

### Relationship between serum vitamin A status and malaria parasite density among participants

Participants with normal serum vitamin A levels predominantly had lower parasite densities, whereas children with moderate or severe vitamin A deficiency were more likely to exhibit high parasite counts. This relationship was statistically significant, reinforcing the observed inverse association between vitamin A status and malaria parasite burden [Table 5].

### Determinants of high malaria parasite count among participants

In multivariate logistic regression analysis, children with moderate vitamin A deficiency had approximately sevenfold higher odds of hyperparasitaemia ( $\geq 200,000$  parasites/ $\mu$ l) compared with those with normal vitamin A levels (OR = 6.81; 95% CI: 1.93–24.05). This association remained statistically significant after adjusting for other vitamin A deficiency categories [Table 6].

## DISCUSSION

This study evaluated and compared serum vitamin A levels in children aged 6 months to 15 years with cerebral malaria and uncomplicated malaria in Sokoto, Nigeria, and examined their relationship with malaria parasite density and selected sociodemographic factors. Although malaria affected both sexes, males constituted a slightly higher proportion of participants with cerebral malaria. Similar sex patterns have been reported in previous studies from Sokoto.<sup>7</sup> Biological differences in immune responses between sexes may partly explain this observation, as females are known to exhibit stronger immune responses than males.<sup>27</sup> In addition, behavioural factors may contribute, since male children often spend more time outdoors and may therefore experience greater exposure to infective bites from female *Anopheles* mosquitoes.<sup>28</sup>

Cultural and social factors, including preferential healthcare-seeking behaviour for male children in some settings, may also influence hospital presentation patterns.<sup>29,30</sup> Cerebral malaria occurred most frequently among children under five years of age, while children aged 10–15 years were least affected. This pattern is consistent with previous reports indicating that younger children are particularly vulnerable to severe malaria because they have not yet developed adequate acquired immunity to *Plasmodium falciparum*.<sup>1,3–7,20,31</sup> The lower incidence among older children suggests the progressive development of partial immunity with repeated exposure to malaria.<sup>7</sup>

Although malaria occurred across all socioeconomic groups, cerebral malaria was more common among children from lower socioeconomic backgrounds. This finding may reflect limited access to preventive measures, delayed healthcare-seeking behaviour, and suboptimal housing conditions that facilitate mosquito breeding and transmission.<sup>32</sup> Socioeconomic disadvantage may also limit timely access to antimalarial medications and reduce awareness of malaria prevention strategies.

The mean serum vitamin A levels observed in both study groups were generally higher than values reported in some earlier studies.<sup>10,13,25</sup> This difference may reflect improvements in vitamin A nutrition in Nigeria following public health interventions such as food fortification and expanded vitamin A supplementation programmes implemented during routine childhood immunisation.<sup>33</sup> These initiatives have likely contributed to improved population vitamin A status in recent years.

Despite these improvements, children with cerebral malaria had significantly lower serum vitamin A levels than those with uncomplicated malaria, with an inverse relationship between vitamin A levels and parasite density. This finding is consistent with previous reports from Nigeria and Malawi demonstrating lower antioxidant vitamin levels in severe malaria compared with uncomplicated disease.<sup>10,12,13,15,25</sup> Vitamin A plays a critical role in immune regulation and functions as an important antioxidant involved in both humoral and cell-mediated immunity.<sup>34</sup>

**Table 1: Sociodemographic characteristics of participants**

| Variables             | Cerebral malaria<br>(n=111)<br>n (%) | Uncomplicated malaria<br>(n=110)<br>n (%) | Test of significance |
|-----------------------|--------------------------------------|-------------------------------------------|----------------------|
| Age groups (years)    |                                      |                                           |                      |
| 6 months to <5 years  | 55 (49.5)                            | 54 (49.1)                                 | $\chi^2 = 0.005$     |
| 5 years to < 10 years | 41 (36.9)                            | 41 (37.3)                                 | $p = 0.998$          |
| 10 to 15 years        | 15 (13.5)                            | 15 (13.6)                                 |                      |
| Sex                   |                                      |                                           |                      |
| Male                  | 65 (56.6)                            | 66 (60.0)                                 | $\chi^2 = 0.048$     |
| Female                | 46 (41.4)                            | 44 (40.0)                                 | $p = 0.827$          |
| M:F ratio             | 1.4:1                                | 1.5:1                                     |                      |
| Social class          |                                      |                                           |                      |
| Upper                 | 10 (9.0)                             | 15 (13.6)                                 | $\chi^2 = 9.21$      |
| Middle                | 37 (33.3)                            | 54 (49.1)                                 | $p = 0.001^*$        |
| Lower                 | 64 (57.7)                            | 41 (37.3)                                 |                      |
| Nutritional status    |                                      |                                           |                      |
| Normal                | 79 (71.2)                            | 74 (67.3)                                 | $\chi^2 = 0.394$     |
| Mild malnutrition     | 32 (28.8)                            | 36 (32.7)                                 | $p = 0.530$          |

$\chi^2$ : Pearson's Chi-square test; \*Statistically significant  $p < 0.05$

**Table 2: Serum vitamin A levels across participants' sociodemographic characteristics**

| Variables             | Mean $\pm$ SD of vitamin A in $\mu\text{g/dl}$ |                        | Test of significance |          |
|-----------------------|------------------------------------------------|------------------------|----------------------|----------|
|                       | Cerebral malaria                               | Uncomplicated malaria  | t                    | p-value  |
| Overall means         | 31.0 $\pm$ 17.7                                | 39.3 $\pm$ 15.5        | -3.72                | < 0.001* |
| Age groups (years)    |                                                |                        |                      |          |
| 6 months to <5 years  | 31.5 $\pm$ 22.8                                | 40.0 $\pm$ 19.5        | -2.09                | 0.039*   |
| 5 years to < 10 years | 32.2 $\pm$ 11.2                                | 39.1 $\pm$ 11.1        | -2.81                | 0.006*   |
| 10 to 15 years        | 26.0 $\pm$ 8.5                                 | 37.7 $\pm$ 8.9         | -3.7                 | 0.001*   |
| Test of significance  | F = 0.700, $p = 0.499$                         | F = 0.127, $p = 0.881$ |                      |          |
| Sex                   |                                                |                        |                      |          |
| Male                  | 31.1 $\pm$ 21.5                                | 40.6 $\pm$ 18.9        | -2.67                | 0.009*   |
| Female                | 30.8 $\pm$ 10.6                                | 37.5 $\pm$ 7.9         | -3.38                | 0.001*   |
| Test of significance  | t = 0.96, $p = 0.924$                          | t = 1.012, $p = 0.314$ |                      |          |

t: Independent t test; F: One-way analysis of variance (ANOVA); \*Statistically significant  $p < 0.05$

**Table 3: Serum vitamin A status according to the severity of malaria among participants**

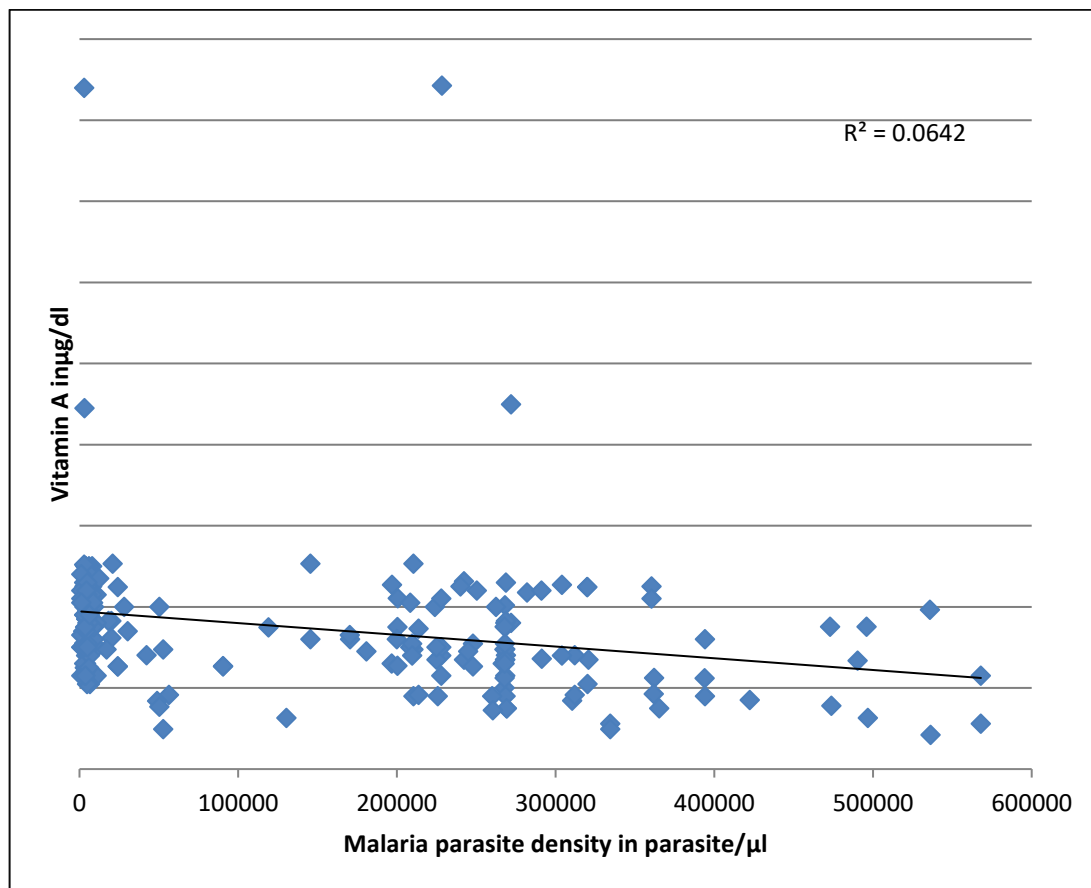
| Serum vitamin A status        | Cerebral malaria<br>(n=111)<br>n (%) | Uncomplicated malaria<br>(n=110)<br>n (%) | Test of significance |
|-------------------------------|--------------------------------------|-------------------------------------------|----------------------|
| Normal vitamin A status       | 47 (35.6)                            | 85 (64.4)                                 | Fe = 44.58           |
| Mild vitamin A deficiency     | 38 (60.3)                            | 25 (39.7)                                 | $p < 0.001^*$        |
| Moderate vitamin A deficiency | 23 (100)                             | 0 (0)                                     |                      |
| Severe vitamin A deficiency   | 3 (100)                              | 0 (0)                                     |                      |

Fe: Fisher's exact test; \*Statistically significant  $p < 0.05$

**Table 4: Malaria parasite density by severity of malaria and participants' sociodemographic characteristics**

| Variables             | Mean $\pm$ SD of vitamin A in $\mu\text{g/dl}$ |                       | Test of significance |          |
|-----------------------|------------------------------------------------|-----------------------|----------------------|----------|
|                       | Cerebral malaria                               | Uncomplicated malaria | t                    | p-value  |
| Overall means         | 251,855 $\pm$ 120,853                          | 5,602 $\pm$ 4,020     | -21.36               | < 0.001* |
| Age groups (years)    |                                                |                       |                      |          |
| 6 months to <5 years  | 250,788 $\pm$ 125,483                          | 5,030 $\pm$ 2,295     | 14.39                | <0.001*  |
| 5 years to < 10 years | 255,057 $\pm$ 112,250                          | 5,843 $\pm$ 5,329     | 14.20                | <0.001*  |
| 10 to 15 years        | 247,014 $\pm$ 134,023                          | 7,000 $\pm$ 4,606     | 6.93                 | <0.001*  |
| Test of significance  | F = 0.280, p = 0.972                           | F = 1.542, p = 0.219  |                      |          |
| Sex                   |                                                |                       |                      |          |
| Male                  | 264,183 $\pm$ 129,395                          | 5,358 $\pm$ 4,350     | 16.24                | <0.001*  |
| Female                | 234,435 $\pm$ 106,582                          | 5,966 $\pm$ 3,483     | 14.21                | <0.001*  |
| Test of significance  | t = 1.281, p = 0.203                           | t = -775, p = 0.440   |                      |          |

t: Independent t test; F: One-way analysis of variance (ANOVA1); \*Statistically significant p < 0.05

**Figure 1: Correlation between serum vitamin A levels and malaria parasite density among participants**



**Table 5: Relationship between serum vitamin A status and malaria parasite density among participants**

| Serum vitamin A status        | Malaria parasite density           |                                    | Test of significance      |
|-------------------------------|------------------------------------|------------------------------------|---------------------------|
|                               | Low (<200,000P/μl); n=135<br>n (%) | High (≥200,000P/μl); n=86<br>n (%) |                           |
| Normal vitamin A status       | 96 (72.6)                          | 34 (39.6)                          | Fe = 31.914<br>p < 0.001* |
| Mild vitamin A deficiency     | 32 (23.7)                          | 31 (36.0)                          |                           |
| Moderate vitamin A deficiency | 4 (3.0)                            | 19 (22.1)                          |                           |
| Severe vitamin A deficiency   | 1 (0.7))                           | 2 (2.3)                            |                           |

Fe: Fisher's exact test; \*Statistically significant p &lt; 0.05

**Table 6: Multivariate regression on serum vitamin A status in relation to malaria parasite density**

| Vitamin A deficiency status | p - value | aOR   | 95% CI for aOR |        |
|-----------------------------|-----------|-------|----------------|--------|
|                             |           |       | Lower          | Upper  |
| Severe                      | 0.253     | 4.686 | 0.332          | 66.24  |
| Moderate                    | 0.003     | 6.81  | 1.928          | 24.051 |
| Mild                        | 0.202     | 1.628 | 0.77           | 3.434  |

aOR: adjusted Odds Ratio; CI: Confidence Interval

During *Plasmodium falciparum* infection, increased oxidative stress and immune activation may accelerate the utilisation of antioxidant micronutrients, leading to reduced circulating vitamin A levels. Reduced dietary intake, malabsorption, impaired transport, and increased urinary loss during acute infection may further contribute to vitamin A depletion.<sup>17</sup>

The lower vitamin A levels observed in children with cerebral malaria may also be related to the higher parasite burden in this group. In the present study, all cases of hyperparasitaemia (≥200,000 parasites/μl) occurred among children with cerebral malaria. Higher parasite densities may intensify oxidative stress and inflammatory responses, thereby increasing the utilisation of antioxidant nutrients such as vitamin A. Similar associations between increased parasitaemia and reduced vitamin A levels have been reported in other Nigerian studies.<sup>10,12,13</sup>

Consistent with these findings, the present study demonstrated a significant inverse correlation between serum vitamin A levels and malaria parasite density. Similar negative correlations have been reported in previous studies.<sup>11–13,15,34</sup> This relationship likely reflects

increased consumption of antioxidant micronutrients during the acute inflammatory response induced by malaria infection.

Importantly, moderate vitamin A deficiency emerged as a significant determinant of hyperparasitaemia in this study. Children with moderate vitamin A deficiency had approximately sevenfold higher odds of developing hyperparasitaemia compared with those with normal vitamin A levels. This finding suggests that suboptimal vitamin A status may predispose children to heavier parasite burdens and potentially more severe malaria infection. Socioeconomic class was not independently associated with parasite density in the multivariate analysis. Overall, these findings highlight the potential role of vitamin A status in modulating malaria severity and parasite burden among children in malaria-endemic settings.

## STUDY LIMITATIONS

The following limitations should be considered when interpreting the findings of this study. Serum vitamin A concentration was used as the indicator of vitamin A

status; however, it may not fully reflect total body vitamin A reserves, as hepatic vitamin A stores, which provide a more accurate estimate of body vitamin A status, were not assessed. In addition, vitamin A intake was not evaluated, limiting the ability to determine the contribution of recent nutrition to the observed serum levels. The cross-sectional design of the study also limits the ability to establish a causal relationship between vitamin A status and malaria severity or parasite density. Furthermore, serum vitamin A concentrations may be influenced by the acute-phase response associated with malaria infection, which could transiently alter circulating micronutrient levels during acute illness. Despite these limitations, the study provides important insights into the relationship between vitamin A status, malaria severity, and parasite burden among children in a malaria-endemic setting.

## CONCLUSION

This study demonstrated that serum vitamin A levels were significantly lower in children with cerebral malaria compared with those with uncomplicated malaria. Serum vitamin A concentrations did not differ significantly across sex or age groups within either malaria category. Children with cerebral malaria also exhibited significantly higher malaria parasite densities than those with uncomplicated malaria, although parasite density did not vary significantly by sex or age within the study groups. Importantly, an inverse relationship was observed between serum vitamin A levels and malaria parasite density, suggesting that poorer vitamin A status is associated with increased parasite burden and greater disease severity. These findings highlight the potential role of vitamin A status in the clinical expression of malaria among children in malaria-endemic settings. Further prospective and randomized interventional studies are warranted to clarify the causal relationship between vitamin A status and malaria severity and to evaluate the potential benefits of vitamin A-based nutritional interventions in reducing malaria-related morbidity.

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## Source of support

Nil.

## Conflict of interest

None declared.

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## Perceptions of Medical Errors Reporting and Management among Physicians in a Teaching Hospital in Northwestern Nigeria

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### ABSTRACT

**Background:** Medical errors pose a significant threat to patient safety and healthcare quality worldwide, particularly in low- and middle-income countries. Physicians' perceptions of error reporting and management influence the effectiveness of patient safety initiatives, yet evidence from Northwestern Nigeria is limited. **Aim:** To assess physicians' perceptions of medical error reporting and management at a teaching hospital in Northwestern Nigeria. **Materials and Methods:** A hospital-based cross-sectional descriptive study was conducted among 191 physicians at Usmanu Danfodiyo University Teaching Hospital, Sokoto. Eight departments were selected using simple random sampling, and eligible physicians were recruited via systematic sampling. Data were collected using a structured, pretested, self-administered questionnaire and analysed with SPSS version 25. Descriptive statistics summarized sociodemographic characteristics and perceptions of error reporting and management. **Results:** The mean age of respondents was  $36.3 \pm 6.3$  years, with a predominance of males (79.6%) and resident doctors (66.5%). Overwork, stress, and fatigue (63.9%), communication gaps (53.4%), and lack of teamwork (44.0%) were perceived as leading causes of medical errors. Laboratory-related (42.9%) and diagnostic errors (41.9%) were most commonly encountered. Key strategies for prevention included spending more time with patients (51.8%) and establishing structured reporting systems (45.0%). Most physicians supported constructive management responses, such as information-seeking (61.3%), reporting through appropriate channels (45.5%), and collegial discussion (36.1%), while avoidance and concealment behaviors were rare. **Conclusion:** Physicians generally hold positive views of medical error reporting and management, favouring learning-oriented, collaborative approaches. Strengthening structured reporting systems and supporting teamwork-based error management could further enhance patient safety in this setting.

**Keywords:** Medical errors, Physician perceptions, Patient safety, Error reporting and management, Northwestern Nigeria

### INTRODUCTION

Medical errors remain a major global public health concern and constitute a significant threat to patient safety and the quality of healthcare delivery. A medical error is generally defined as the failure of a planned action to be completed as intended or the use of an incorrect plan to achieve a healthcare aim.<sup>1</sup> Such errors may occur at any stage of healthcare delivery, including diagnosis, treatment, laboratory investigations, medication administration, or surgical procedures. Globally, medical errors contribute substantially to preventable morbidity and mortality, particularly in low- and middle-income countries where healthcare systems often face workforce shortages, inadequate infrastructure, and limited safety monitoring systems.<sup>1,2</sup> Estimates suggest that millions of patients worldwide experience preventable harm during healthcare delivery each year, highlighting the urgent need for improved patient safety practices and stronger error reporting systems.<sup>1,3</sup>

Effective reporting and management of medical errors are central components of patient safety improvement strategies. Error-reporting systems allow healthcare institutions to identify systemic weaknesses, implement corrective measures, and prevent the recurrence of similar incidents.<sup>4,5</sup> Transparent disclosure and reporting of medical errors also promote organizational learning and foster a culture of accountability and safety within healthcare settings. However, despite the recognized benefits of reporting systems, underreporting of medical errors remains a persistent challenge in many healthcare institutions worldwide.<sup>5,6</sup>

Factors such as fear of litigation, professional stigma, punitive institutional cultures, and lack of clear reporting mechanisms often discourage healthcare professionals from reporting errors, thereby limiting opportunities for system-wide improvements.<sup>4,6</sup>

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In Nigeria and other low- and middle-income countries, the burden of medical errors may be particularly pronounced due to systemic challenges within healthcare systems. Overcrowded facilities, heavy workload, inadequate staffing, and limited resources often place significant pressure on healthcare providers, increasing the likelihood of errors occurring during patient care.<sup>7,8</sup> Studies conducted in Nigerian tertiary hospitals have identified factors such as excessive workload, communication failures among healthcare teams, and inadequate supervision as key contributors to medical errors.<sup>7,9</sup> Similar findings have been reported in other West African countries, where workforce shortages and infrastructural limitations have been linked to increased risk of patient safety incidents.<sup>10,11</sup> These contextual challenges highlight the importance of understanding how physicians perceive the causes, reporting practices, and management of medical errors within their clinical environments.

Physicians play a pivotal role in recognizing, reporting, and managing medical errors. Their perceptions regarding error causation, reporting processes, and appropriate management responses significantly influence whether errors are disclosed and addressed effectively within healthcare systems.<sup>5,6</sup> Positive perceptions toward error reporting have been associated with increased transparency, improved teamwork, and enhanced patient safety outcomes. Conversely, negative perceptions or a lack of awareness regarding reporting procedures may contribute to underreporting and the perpetuation of unsafe practices.<sup>3,4</sup> Understanding physicians' perceptions is therefore essential for designing targeted interventions to strengthen institutional safety cultures and improve reporting systems.

In addition, identifying commonly encountered types of medical errors and physicians' perceived strategies for preventing them can provide valuable insights for healthcare administrators and policymakers. Evidence from previous studies suggests that medication errors, diagnostic errors, laboratory-related errors, and delays in clinical interventions are among the most frequently reported patient safety incidents in hospital settings.<sup>5,10</sup> Preventive strategies such as improving communication among healthcare professionals, strengthening teamwork, enhancing supervision, and implementing structured reporting systems have been widely recommended to reduce medical errors.<sup>6,8</sup> However, the extent to which

physicians perceive these strategies as effective may vary depending on institutional culture, training, and workload conditions.

Despite growing recognition of patient safety issues, empirical evidence on physicians' perceptions of medical error reporting and management in Nigeria remains limited. Most existing studies have focused primarily on specific types of errors or patient safety culture without exploring physicians' perspectives on the broader processes of error reporting and management.<sup>7,9</sup> Furthermore, data from the Northwestern region of Nigeria are relatively scarce, despite the presence of several tertiary healthcare institutions serving large populations. Understanding physicians' perceptions in this context is critical for identifying gaps in reporting practices and for developing effective institutional policies to reduce preventable harm. Therefore, this study aimed to assess physicians' perceptions of medical error reporting and management at a teaching hospital in Northwestern Nigeria. Findings from this study are expected to contribute to the growing body of evidence on patient safety in Nigeria and provide insights to strengthen error-reporting systems and improve the quality of healthcare delivery in tertiary healthcare institutions.

## **MATERIALS AND METHODS**

### **Study Design, Population, and Area**

This was a hospital-based cross-sectional descriptive study conducted among physicians at Usmanu Danfodiyo University Teaching Hospital, Sokoto metropolis, Northwestern Nigeria. The study population comprised medical doctors working in the hospital. Only physicians who had been in employment for at least six (6) months prior to the study were considered eligible and enrolled.

### **Sample Size Estimation and Sampling Technique**

The sample size was estimated at 191 using the formula for calculating the sample size for a single proportion,<sup>12</sup> based on a 66.0% prevalence of self-reported medical errors in a study among doctors,<sup>13</sup> a precision level of 5%, and an anticipated 95% response rate. A multistage sampling technique was used to select participants. In the first stage, eight departments were selected from a total of 24 departments in the hospital using simple random sampling by balloting. In the second stage, a systematic sampling technique was used to select eligible physicians



within each selected department. The staff list of each department served as the sampling frame, and proportionate allocation was applied based on the number of physicians in each department to ensure adequate representation.

### Data Collection

Data were collected using a structured self-administered questionnaire. The questionnaire was developed after a review of relevant literature on medical errors reporting and management, and it consisted of three sections designed to obtain information on respondents' sociodemographic characteristics and their perceptions of medical error reporting and management. The study instrument was reviewed by senior researchers in the Department of Community Health, Usmanu Danfodiyo University, Sokoto, Nigeria, to ensure content validity. The questionnaire was pretested among 20 doctors in two departments that were not selected for the study to identify potential ambiguities and ensure the clarity of the questions. Necessary modifications were made to the instrument following the pretest before the commencement of the main study.

### Data Analysis

The collected data were reviewed for completeness and subsequently entered into the Statistical Package for the Social Sciences (SPSS) version 25.0 for analysis. Descriptive statistical methods were applied to summarize the data. Categorical variables were expressed as frequencies and percentages, whereas continuous variables, such as age, were summarized using means and standard deviations. The findings were presented in both textual and tabular formats, as appropriate, to enhance clarity and interpretation.

### Ethical Consideration

Ethical approval for the study was obtained from the Ethical Committee of Usmanu Danfodiyo University Teaching Hospital. Permission to conduct the study was also obtained from the heads of the selected departments. The purpose of the study was explained to all participants, and they were assured that the information provided would be kept confidential. Participation was voluntary, and informed written consent was obtained from each respondent prior to data collection.

## RESULTS

### Sociodemographic characteristics of respondents

A total of 191 physicians participated in the study. The respondents' ages ranged from 25 to 56 years, with a mean age of  $36.3 \pm 6.3$  years. The majority were in the 30–39 age group (62.3%), followed by those aged 40–49 (19.4%), 20–29 (14.1%), and only 4.2% were aged 50–59. Most respondents were male (79.6%), married (82.7%), and Muslim (70.7%), while 28.8% were Christian and 0.5% reported other religions. The duration of medical practice ranged from 1 to 27 years, with a mean of  $9.4 \pm 5.4$  years. More than half of the respondents (57.1%) had 1–9 years of professional experience, 39.8% had 10–19 years, and 3.1% had 20–29 years. Respondents reported a median weekly working time of 60 hours, with working hours ranging from 8 to 168 hours. The majority (59.7%) worked 50–99 hours per week, while 28.8% worked fewer than 50 hours, 9.9% worked 100–149 hours, and 1.6% worked 150–199 hours. Regarding professional rank, resident doctors constituted the largest proportion (66.5%), followed by consultants (20.4%), while medical officers accounted for 13.1% of respondents [Table 1].

**Table 1: Sociodemographic characteristics of respondents**

| Variables                  | Frequency (%) n = 191 |
|----------------------------|-----------------------|
| Age group (years)          |                       |
| 20-29                      | 27 (14.1)             |
| 30-39                      | 119 (62.3)            |
| 40-49                      | 37 (19.4)             |
| 50-59                      | 8 (4.2)               |
| Sex                        |                       |
| Male                       | 152 (79.6)            |
| Female                     | 39 (20.4)             |
| Marital status             |                       |
| Single                     | 31 (16.2)             |
| Married                    | 158 (82.7)            |
| Widowed                    | 2 (1.0)               |
| Religion                   |                       |
| Islam                      | 135 (70.7)            |
| Christianity               | 55 (28.8)             |
| Others                     | 1 (0.5)               |
| Length of practice (years) |                       |
| 1-9                        | 109 (57.1)            |
| 10-19                      | 76 (39.8)             |
| 20-29                      | 6 (3.1)               |
| Working hours per week     |                       |
| 1-49                       | 55 (28.8)             |
| 50-99                      | 114 (59.7)            |
| 100-149                    | 19 (9.9)              |
| 150-199                    | 3 (1.6)               |
| Rank                       |                       |
| Medical officers           | 25 (13.1)             |
| Residents                  | 127 (66.5)            |
| Consultants                | 39 (20.4)             |

### Perceived causes of medical errors by respondents

Respondents identified several factors they believed contributed to medical errors. The most frequently perceived cause was overwork, stress, and fatigue (63.9%). This was followed by communication gaps (53.4%) and communication failures (51.3%) among healthcare professionals. Other commonly perceived contributing factors included lack of teamwork (44.0%), absence of close patient monitoring (29.3%), and insufficient time spent with patients (28.8%). Less frequently reported causes included lack of patient cooperation (18.8%), superficial backup or consultation (16.8%), understaffing of nurses (16.2%), undertrained physicians (14.7%), and lack of strong leadership (12.6%) [Table 2].

**Table 2: Perceived causes of medical errors by respondents**

| Causes of medical errors                          | Frequency (%)<br>n = 191 |
|---------------------------------------------------|--------------------------|
| Not having enough time with the patient           | 55 (28.8)                |
| Overwork, stress, and fatigue                     | 112 (63.9)               |
| Communication failures among health professionals | 98 (51.3)                |
| Understaffing of nurses                           | 31 (16.2)                |
| Lack of cooperation from the patient              | 36 (18.8)                |
| Absence of close monitoring                       | 56 (29.3)                |
| Lack of teamwork                                  | 84 (44.0)                |
| Communication gap                                 | 102 (53.4)               |
| Lack of strong leadership                         | 24 (12.6)                |
| Superficial backup and consultation               | 32 (16.8)                |
| Undertrained physicians                           | 28 (14.7)                |

### Perceived strategies for preventing medical errors by respondents

More than half of the respondents (51.8%) believed that allowing physicians more time to spend with patients would significantly reduce medical errors. Nearly half (45.0%) also supported encouraging hospitals to voluntarily report serious medical errors to a state agency, reflecting recognition of the role of structured reporting systems in improving patient safety. However, fewer respondents endorsed procedural or staffing measures as key preventive strategies. Only 28.8% believed that counting surgical items during invasive procedures would reduce errors, while 22.5% considered increasing the

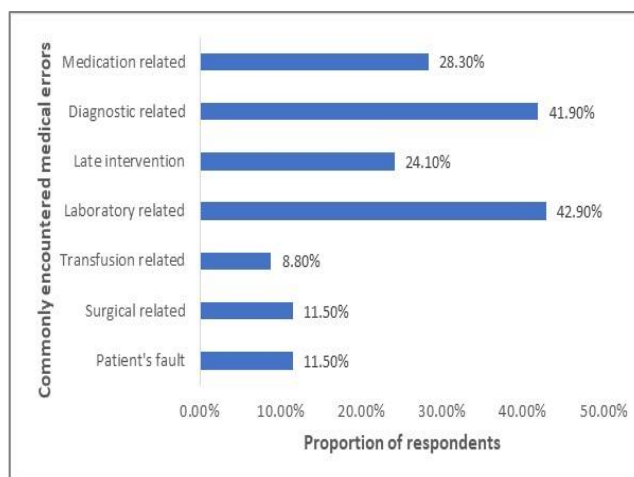
number of nurses as an effective preventive strategy [Table 3].

**Table 3: Perceived strategies for preventing medical errors by respondents**

| Strategies for preventing medical errors                               | Frequency (%)<br>n = 191 |
|------------------------------------------------------------------------|--------------------------|
| Giving physicians more time to spend with the patient                  | 99 (51.8)                |
| Increasing the number of nurses                                        | 43 (22.5)                |
| Counting surgical items during an invasive surgical procedure          | 55 (28.8)                |
| Encourage hospitals to report errors voluntarily to the state agencies | 86 (45.0)                |

### Perceived commonly encountered medical errors by respondents

Respondents reported that laboratory-related errors were the most commonly encountered type of medical error (42.9%), closely followed by diagnostic errors (41.9%). Other frequently perceived errors included medication-related errors (28.3%) and delayed or late clinical intervention (24.1%). Less frequently reported errors were surgical-related (11.5%) and patient-related (11.5%), while transfusion-related errors were the least commonly reported (8.8%) [Figure 1].



**Figure 1: Perceived commonly encountered medical errors by respondents**

### Respondents' perception of the benefits of medical error reporting for patients

Most respondents (65.4%) believed that medical error reporting helps patients receive better quality treatment. Other commonly identified benefits included improved patient safety (40.8%), prevention of health hazards (39.8%), and saving patients' lives (38.7%). Approximately one-third of the respondents perceived additional benefits such as avoiding medico-legal implications (33.5%) and facilitating correction of errors (31.4%). Fewer respondents indicated that medical error reporting could reduce hospitalization duration (15.2%) or medical costs (13.6%) [Table 4].

**Table 4: Respondents' perception of the benefits of medical error reporting for patients**

| Patients' benefits from medical error reporting | Frequency (%)<br>n = 191 |
|-------------------------------------------------|--------------------------|
| Helps receive quality treatment                 | 125 (65.4)               |
| Helps prevent health hazards                    | 76 (39.8)                |
| Reduces hospitalization                         | 29 (15.2)                |
| Saves a patient's life                          | 74 (38.7)                |
| Helps correct the errors                        | 60 (31.4)                |
| Reduction of medical bills                      | 26 (13.6)                |
| Improves patients' safety                       | 38 (40.8)                |
| Helps avoid medicolegal implications            | 64 (33.5)                |

### Perceived management of medical errors by respondents

Regarding appropriate responses when medical errors occur, the majority of respondents (61.3%) believed physicians should increase information-seeking to better understand the error. Nearly half (45.5%) reported that errors should be reported through appropriate channels, while 36.1% recommended discussing the issue with colleagues. Conversely, very few respondents supported avoidance behaviors such as avoiding similar patients or circumstances (11.0%), and only 0.5% indicated that concealment of the error was appropriate [Table 5].

**Table 5: Perceived management of medical errors by respondents**

| Actions to be taken by a physician when medical errors occur | Frequency (%)<br>n = 191 |
|--------------------------------------------------------------|--------------------------|
| Conceal it                                                   | 1 (0.5)                  |
| Avoid similar patients or circumstances                      | 21 (11.0)                |
| Increase information seeking                                 | 69 (36.1)                |
| Discuss with colleagues                                      | 87 (45.5)                |

### DISCUSSION

This study provides important insights into physicians' perceptions of medical error reporting and management in a tertiary healthcare setting in Northwestern Nigeria. The predominance of relatively young, early-career physicians, most of whom were resident doctors with a mean practice duration of less than 10 years, reflects the workforce composition typical of teaching hospitals in Nigeria. The long working hours reported by respondents, with a median of 60 hours per week, highlight the demanding nature of clinical practice in such settings and may have implications for patient safety. Similar patterns of workforce strain have been reported in Nigerian and other sub-Saharan African settings, where high patient loads and limited staffing contribute to increased risk of errors.<sup>7,11</sup> Furthermore, evidence from Nigeria indicates that high workload and systemic pressures are closely associated with increased exposure to medical errors and adverse events among healthcare workers.<sup>14,15</sup>

The findings that overwork, stress, and fatigue were the most commonly perceived causes of medical errors align with global and regional evidence identifying human factors as major contributors to adverse events. Excessive workload has been consistently linked to reduced cognitive performance, impaired decision-making, and increased likelihood of clinical errors.<sup>5,10</sup> Additionally, communication gaps and failures among healthcare professionals were prominently reported, underscoring the critical role of effective teamwork and information exchange in ensuring patient safety. Previous studies have similarly demonstrated that poor communication is a leading cause of preventable harm in healthcare systems.<sup>3,6</sup> In sub-Saharan Africa, weak communication systems and hierarchical barriers have been shown to hinder effective error reporting and teamwork.<sup>16,17</sup>

In terms of preventive strategies, respondents emphasized the need for more time with patients and for establishing structured reporting systems. This suggests an appreciation of both patient-centered care and systemic approaches to error reduction. However, the relatively low endorsement of procedural safeguards, such as surgical counts, and staffing improvements, such as increasing the number of nurses, may reflect limited awareness of evidence-based safety interventions or contextual constraints within the health system. Studies in low- and middle-income countries have shown that strengthening institutional policies, including staffing

adequacy and adherence to safety protocols, significantly reduces medical errors.<sup>1,8</sup> Additionally, poor implementation of safety protocols and low awareness of standardized procedures have been reported among clinicians in Nigeria, further contributing to preventable errors.<sup>14,18</sup>

The predominance of laboratory-related and diagnostic errors reported in this study is noteworthy and may reflect systemic inefficiencies in diagnostic processes, including delays, inadequate infrastructure, or human error. This finding is consistent with reports from similar settings, where diagnostic errors constitute a substantial proportion of adverse events due to limited access to diagnostic tools and high patient volumes.<sup>3,9</sup> In many African healthcare systems, challenges such as inadequate laboratory capacity and delayed test results further exacerbate diagnostic inaccuracies.<sup>14,15</sup> Additionally, global evidence indicates that diagnostic errors are among the most common and harmful types of medical errors, particularly in resource-constrained settings where system-level weaknesses persist.<sup>19,20</sup>

Encouragingly, a substantial proportion of respondents recognized the benefits of medical error reporting, particularly in improving the quality of care and patient safety. This positive perception aligns with evidence that effective reporting systems facilitate learning from errors, enhance transparency, and promote safer clinical practices.<sup>1,4</sup> However, the relatively lower recognition of economic benefits, such as reduced hospitalization costs and duration, may indicate a limited understanding of the broader health system impact of patient safety initiatives. Previous studies in Nigeria have also shown that despite awareness of the importance of reporting, actual reporting practices remain suboptimal due to fear of blame and lack of supportive systems.<sup>14,17</sup> Recent global and regional evidence further highlights that well-implemented patient safety and incident reporting systems are associated with improved clinical outcomes and more efficient resource utilization, while persistent cultural and structural barriers continue to limit optimal reporting practices in low- and middle-income countries.<sup>21,22</sup>

Regarding error management, most physicians supported constructive responses such as increased information-seeking, reporting through appropriate channels, and collegial discussion. These findings suggest a generally

positive attitude toward learning-oriented and systems-based approaches to error management. Notably, very few respondents endorsed concealment or avoidance behaviors, a promising sign of an emerging culture of openness and accountability. This is consistent with studies showing that fostering a non-punitive environment encourages healthcare workers to report errors and engage in corrective actions.<sup>2,6</sup> However, evidence from African settings indicates that blame culture and lack of psychological safety still persist and can negatively affect reporting behaviors.<sup>15,16</sup>

Overall, the findings highlight both strengths and gaps in physicians' perceptions of medical error reporting and management. While there is clear recognition of key contributing factors and the benefits of reporting, there is a need for enhanced training in evidence-based preventive strategies and institutional support for patient safety systems. Strengthening communication, reducing workload, and promoting a culture of safety through structured reporting mechanisms should be prioritized to improve patient outcomes in similar settings.<sup>8,11</sup>

## STUDY LIMITATIONS

This study has some limitations. Its cross-sectional design precludes causal inference, and reliance on self-reported data introduces potential for social desirability and recall biases, particularly given the sensitive nature of medical errors. Additionally, the single-center setting may limit the generalizability of the findings to other healthcare contexts. Finally, the study focused only on physicians, excluding other healthcare professionals involved in patient care.

## CONCLUSION

Physicians in this study generally held positive perceptions of medical error reporting and management, favoring learning-oriented and systems-based approaches. The predominance of constructive responses, such as information-sharing and collegial discussion, indicates an emerging culture of openness and professional accountability. Based on these findings, strengthening structured reporting systems and supporting collaborative error management strategies could further reinforce safe clinical practices in this setting.



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Nil.

## Conflict of interest

None declared.

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# Paroxysmal Dyskinesias in Children: Diagnostic Challenges and Misdiagnosis as Epilepsy in Resource-Limited Sub-Saharan Africa - A Narrative Review

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## ABSTRACT

**Background:** Paroxysmal dyskinesias (PD) are rare, episodic movement disorders in children characterized by sudden, transient involuntary movements with preserved consciousness. In resource-limited Sub-Saharan Africa, they are frequently underrecognized and misdiagnosed as epilepsy due to overlapping clinical features and limited diagnostic capacity, resulting in inappropriate management and avoidable morbidity. **Aim:** To provide a comprehensive narrative overview of pediatric PD, with emphasis on clinical features, diagnostic challenges, and misdiagnosis as epilepsy in resource-constrained Sub-Saharan African settings. **Methods:** A narrative review of published literature was conducted using electronic databases, including MEDLINE, ScienceDirect, Google Scholar, and World Health Organization resources. Eligible studies included descriptive, observational, and review articles addressing pediatric PD, diagnostic challenges, and health-system factors. Findings were synthesized qualitatively. **Data Synthesis:** Paroxysmal dyskinesias typically present with stereotyped, trigger-induced episodes of dystonia or choreoathetosis, preserved awareness, and normal interictal neurological function. Misdiagnosis as epilepsy is common, driven by clinical overlap, high epilepsy prevalence, limited access to EEG, neuroimaging, and genetic testing, and low clinician awareness. Diagnostic delays are frequent, leading to unnecessary long-term antiepileptic therapy, financial burden, and psychosocial stigma. However, accurate diagnosis is achievable through careful clinical assessment, recognition of triggers, and use of pragmatic tools such as caregiver-recorded videos. Management is generally effective, combining low-dose pharmacotherapy, trigger avoidance, and supportive care. **Conclusion:** Strengthening clinical awareness, improving diagnostic capacity, and adopting low-cost, context-appropriate strategies are essential to reduce misdiagnosis and improve outcomes for children with PD in resource-limited settings.

**Keywords:** Paroxysmal dyskinesias, Epilepsy misdiagnosis, Pediatric movement disorders, Diagnostic challenges, Sub-Saharan Africa

## INTRODUCTION

Paroxysmal dyskinesias (PD) are a heterogeneous group of rare, episodic movement disorders characterized by sudden, transient attacks of involuntary movements, including dystonia, chorea, athetosis, or mixed phenomenology, occurring in the context of preserved consciousness and typically with a normal neurological examination between episodes.<sup>1</sup> Affected children, particularly in primary (genetic) forms, generally exhibit normal cognitive development and neurological function during interictal periods, which may contribute to under-recognition of the disorder in routine clinical practice.<sup>1,2</sup> The condition most commonly begins in childhood or adolescence, with distinct temporal patterns across subtypes: paroxysmal kinesigenic dyskinesia (PKD) often presents between 5 and 15 years of age, paroxysmal non-kinesigenic dyskinesia (PNKD) frequently begins in early

childhood, and paroxysmal exercise-induced dyskinesia (PED) typically manifests during late childhood or adolescence, particularly in the school-age years.<sup>1,2</sup>

The clinical recognition of PD has evolved considerably over time. Early descriptions in the late nineteenth and early twentieth centuries documented patients with recurrent involuntary movements without loss of consciousness, although such cases were frequently misclassified as “reflex epilepsy” or functional (“hysterical”) disorders due to limited understanding of their underlying mechanisms.<sup>3,4</sup> Foundational contributions by early neurologists, including observations by Gilles de la Tourette, helped delineate episodic motor phenomena distinct from other movement disorders. A major milestone was achieved in

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1940 with the detailed description of familial paroxysmal choreoathetosis, which emphasized preserved consciousness and normal neurological status between attacks, thereby distinguishing PD from epileptic seizures.<sup>3,4</sup>

Subsequent advances in clinical characterization led to the introduction of the term paroxysmal kinesigenic choreoathetosis by Kertesz in 1967, highlighting attacks triggered by sudden voluntary movement and initiating a classification framework based on precipitating factors.<sup>5</sup> This work culminated in the widely accepted classification proposed by Demirkiran and Jankovic in 1995, which categorized PD into PKD, PNKD, and PED, forming the basis of contemporary diagnostic approaches.<sup>1,3–5</sup>

The advent of electroencephalography (EEG) and neuroimaging further refined the distinction between PD and epilepsy, demonstrating the absence of epileptiform activity during attacks and typically normal structural imaging in primary forms. These findings supported the conceptualization of PD as functional or network disorders rather than epileptic conditions. Advances in molecular genetics between 2004 and 2011 provided critical insights into the biological basis of PD, with the identification of pathogenic variants in genes such as *PRRT2*, *PNKD*, and *SLC2A1*. These discoveries established PD as part of a broader group of genetically mediated channelopathies and synaptopathies, with notable clinical and mechanistic overlap with epilepsy and migraine within a spectrum of paroxysmal neurodevelopmental disorders.<sup>6</sup>

Despite these advances, the epidemiology of PD in children remains poorly defined, particularly in low- and middle-income regions. Available data from high-income countries suggest that PKD is the most common subtype in pediatric populations, with estimated prevalence ranging from approximately 1 in 150,000 to 1 in 1,000,000, while PNKD and PED are considerably rarer.<sup>1,7,8</sup> Both sporadic and familial forms are recognized, with autosomal dominant inheritance and variable penetrance commonly observed in genetic cases. PKD demonstrates a male predominance, whereas PNKD shows a more equal sex distribution, and PED typically affects school-aged children and adolescents.<sup>1,7,8</sup> Although PD has been reported across diverse ethnic groups, the predominance of published cases from Asia likely reflects greater diagnostic awareness and access to genetic testing rather than true geographic variation in

disease burden. Reports from Sub-Saharan Africa, including Nigeria, remain exceedingly limited, suggesting substantial under-recognition and underreporting.<sup>9</sup>

The pathophysiology of PD is complex and incompletely understood, but current evidence implicates dysfunction in basal ganglia and thalamocortical circuits, abnormalities in synaptic transmission, and ion channel dysregulation.<sup>7</sup> Primary PD is largely genetic, with *PRRT2* mutations most commonly associated with childhood-onset PKD, while *SLC2A1* mutations are linked to PED and glucose transporter type 1 (GLUT1) deficiency syndrome.<sup>6,7</sup> Secondary forms arise from identifiable neurological or systemic conditions, including structural brain lesions, metabolic derangements, infections, and inflammatory disorders. PD frequently coexists with other paroxysmal neurological conditions, particularly epilepsy and migraine, reflecting shared genetic and pathophysiological mechanisms.<sup>6,13,19</sup> For instance, benign infantile seizures are commonly observed in individuals with *PRRT2* mutations, underscoring the close relationship between PD and epileptic disorders.<sup>6</sup>

Genetic heterogeneity further complicates the clinical landscape. While mutations in the *PNKD* (MR-1) gene have been identified in patients with classic PNKD phenotypes, not all cases demonstrate a clear genetic basis, highlighting limitations of current diagnostic approaches.<sup>10–12</sup> Environmental triggers such as caffeine and alcohol, linked to MR-1–related neurotoxicity, may provide important clinical clues in such cases.<sup>10,11</sup> Similarly, linkage studies in PED have yielded inconsistent findings, although associations with chromosomal loci and syndromic presentations involving epilepsy, developmental delay, and migraine suggest the existence of additional, yet unidentified genetic determinants.<sup>14,15</sup>

Clinically, PD is classified based on etiology, precipitating factors, and duration of attacks.<sup>1,16</sup> Primary forms are typically genetic and characterized by episodic symptoms with normal interictal neurological function, whereas secondary forms are associated with persistent neurological abnormalities reflective of underlying pathology.<sup>1,20</sup> Classification by triggers further distinguishes PKD (precipitated by sudden movement), PNKD (triggered by stress, fatigue, or dietary factors), and PED (induced by prolonged physical exertion), each with distinct clinical profiles and therapeutic implications.<sup>7,10,14,21</sup> Notably, PKD often responds

dramatically to low-dose anticonvulsants such as carbamazepine, a feature that paradoxically contributes to diagnostic confusion with epilepsy.<sup>7,10</sup>

In resource-limited settings, particularly in Sub-Saharan Africa, the diagnostic distinction between PD and epilepsy presents a significant clinical challenge. The high burden of epilepsy, coupled with limited access to specialized pediatric neurology services and diagnostic tools such as EEG, neuroimaging, and genetic testing, predisposes to frequent misclassification of PD as epileptic seizures.<sup>9</sup> This challenge is further compounded by low clinician awareness of movement disorders, limited subspecialty training, and systemic healthcare constraints. As a result, many children with PD are inappropriately treated with long-term antiepileptic medications, often with suboptimal clinical response.

The consequences of misdiagnosis are substantial. Inappropriate treatment exposes affected children to unnecessary medication-related adverse effects, financial burden, and psychosocial stigma, while delaying accurate diagnosis and targeted management.<sup>22,23</sup> In certain genetic forms, such as GLUT1 deficiency syndrome, failure to recognize PD may result in missed opportunities for effective interventions, including dietary therapies.<sup>6</sup> Furthermore, the paucity of region-specific data on PD in Sub-Saharan Africa perpetuates gaps in clinical awareness, research, and policy development, thereby limiting improvements in diagnostic accuracy and patient outcomes.

Given these challenges, there is a critical need for a comprehensive synthesis of current evidence to enhance recognition and understanding of PD in children, particularly within resource-constrained settings. This narrative review aims to provide an in-depth overview of paroxysmal dyskinesias in the pediatric population, with specific emphasis on diagnostic challenges and the frequent misdiagnosis as epilepsy in Sub-Saharan Africa. By integrating existing knowledge with contextual realities, this review seeks to improve clinical awareness, promote accurate diagnosis, and inform more effective management strategies for affected children in the region.

## METHODS

A narrative review approach was adopted to synthesize available evidence on paroxysmal dyskinesias (PD) in

children, with particular emphasis on diagnostic challenges and misdiagnosis as epilepsy in resource-limited settings of Sub-Saharan Africa. This design was considered most appropriate given the rarity of PD, the predominance of descriptive and observational literature, and the marked heterogeneity in study designs, populations, and reported outcomes. The review integrates historical perspectives, clinical characteristics, epidemiological data, and health system factors to provide a comprehensive understanding of the condition in both global and African contexts.

A comprehensive literature search was conducted using electronic databases, including MEDLINE (via PubMed), ScienceDirect, Google Scholar, and the World Health Organization databases, to identify relevant full-text articles published in English through February 2026. These databases were selected for broad coverage across neurology, pediatrics, and global health literature, with particular attention to studies originating from or relevant to low- and middle-income countries. The search strategy incorporated combinations of keywords and Boolean operators derived from four core domains: the disease entity, diagnostic considerations, population group, and geographic or health-system context. Search terms included “paroxysmal dyskinesia,” “paroxysmal kinesigenic dyskinesia,” “paroxysmal non-kinesigenic dyskinesia,” “paroxysmal exercise-induced dyskinesia,” and “episodic movement disorders,” combined with terms such as “misdiagnosis,” “diagnostic challenge,” “differential diagnosis,” “epilepsy mimic,” and “non-epileptic events,” alongside “children,” “pediatric,” “adolescents,” and contextual terms including “Sub-Saharan Africa,” “resource-limited settings,” “low- and middle-income countries,” and “Africa.” Boolean combinations, for example (“paroxysmal dyskinesia” AND “epilepsy” AND “misdiagnosis” AND “children”), were used to refine search outputs. Additional relevant studies were identified through manual screening of the reference lists of retrieved articles.

Studies were considered eligible if they reported on paroxysmal dyskinesias or related episodic movement disorders in pediatric populations, including descriptive, epidemiological, hospital-based, and review studies. Publications addressing diagnostic challenges, misclassification, or health system limitations were prioritized. Studies conducted globally were included to provide comparative insights, with particular attention to

those addressing African or other resource-constrained settings. Only articles published in English with an accessible full text were included. Reports focusing exclusively on adult populations without pediatric data, and studies lacking sufficient methodological detail were excluded. Titles and abstracts of retrieved records were screened for relevance, followed by full-text assessment of potentially eligible articles.

A total of 41 relevant publications met the inclusion criteria and were included in the final synthesis. Given the heterogeneity in study designs, sample sizes, and reported outcomes, quantitative meta-analysis was not feasible. Instead, data were synthesized qualitatively, with emphasis on recurring themes pertinent to pediatric PD in resource-limited settings. These included the influence of high epilepsy prevalence on diagnostic overshadowing, underreporting of PD in clinical and community settings, reliance on clinical judgment in the absence of diagnostic tools such as electroencephalography and neuroimaging, and the use of anticonvulsant therapy, reinforcing diagnostic misclassification. Additional considerations included the scarcity of trained pediatric neurologists and movement disorder specialists, as well as the emerging role of low-cost diagnostic adjuncts such as caregiver-recorded videos in improving clinical recognition.

Findings from African contexts were interpreted alongside global evidence on epidemiology, genetics, and pathophysiology to highlight disparities in diagnostic capacity and disease recognition between high-income and resource-limited settings. Case reports and small case series were included to illustrate characteristic clinical presentations and diagnostic dilemmas, particularly in resource-limited settings, but were interpreted with caution regarding generalizability. This integrative approach was intended to provide a clinically relevant and context-sensitive synthesis to inform improved recognition, diagnosis, and management of paroxysmal dyskinesias in children.

## DATA SYNTHESIS

### Clinical Features

#### Movement Phenomenology

Paroxysmal dyskinesias are characterized by sudden, brief, and recurrent episodes of involuntary hyperkinetic movements, with complete or near-complete resolution between attacks. The predominant phenomenology includes dystonia and choreoathetosis, with ballistic

movements occurring less frequently. Tremor and myoclonus are generally not typical features, and their presence should prompt consideration of alternative diagnoses.<sup>7</sup> The episodic nature, with abrupt onset and termination, distinguishes PD from other movement disorders that exhibit a more continuous or fluctuating course over time.

#### Trigger Patterns

Attacks may occur spontaneously or be precipitated by identifiable triggers, often consistent within individual patients. Sudden voluntary movement or startle commonly provokes attacks in PKD, whereas PNKD episodes are typically triggered by stress, fatigue, sleep deprivation, caffeine-containing beverages, alcohol, or emotional stimuli. PED is characteristically induced by prolonged physical exertion. Additional triggers such as dehydration and, in adolescent females, menstruation have also been reported.<sup>7,20,24</sup> Recognition of these reproducible triggers provides an important diagnostic clue and helps differentiate PD from other paroxysmal neurological conditions.

#### Distribution of Movements

The distribution of dyskinetic movements varies by subtype but is often stereotyped in each patient. PKD frequently involves the upper limbs, whereas PED more commonly affects the lower limbs. Movements may be unilateral or bilateral and can extend to involve the face, neck, and trunk in more severe episodes. Although the pattern of involvement tends to be consistent, variability between attacks may occur.<sup>20,24</sup>

#### Interictal Normality

A defining feature of primary PD is the preservation of normal neurological function between episodes. Children typically demonstrate normal cognition, neurological examination, and developmental milestones during interictal periods.<sup>1,20</sup> This interictal normality, while diagnostically helpful, may also contribute to under-recognition, particularly in settings where episodic symptoms are not directly observed by clinicians.

### Differential Diagnosis

#### Epilepsy Mimics

Epilepsy represents the most common and clinically significant mimic of PD. Conditions such as focal epilepsies, particularly frontal lobe seizures and focal aware seizures with motor features, may closely resemble dyskinetic episodes. Reflex epilepsies triggered by



movement or sensory stimuli further complicate differentiation. Other conditions that may be confused with PD include benign infantile seizures, nocturnal seizure disorders with dystonic features, episodic ataxias, tetany, periodic paralyses, and neuromyotonia.<sup>20,25,26</sup> The overlap in episodic motor manifestations and triggering factors necessitates careful clinical evaluation.

Distinguishing PD from epilepsy relies primarily on clinical semiology, including preserved consciousness, stereotyped triggers, brief duration of attacks, and normal interictal examination. Electroencephalography, where available, is useful in excluding epileptiform activity. Misdiagnosis has significant implications, including inappropriate labeling of epilepsy, unnecessary long-term treatment, and psychosocial consequences.<sup>26</sup>

### Functional Movement Disorders

Functional movement disorders (FMD) represent another important consideration in the differential diagnosis. These disorders are characterized by variability, inconsistency, distractibility, and suggestibility of movements, often changing with attention or observation.<sup>27,28</sup> In contrast, PD is typically associated with consistent and reproducible triggers, stereotyped attack patterns, and preserved awareness. However, coexistence of functional symptoms and organic movement disorders may occur, further complicating diagnosis.<sup>7,29</sup>

### Paroxysmal Non-Epileptic Events

Several non-epileptic paroxysmal conditions in children may mimic PD, including breath-holding spells, shuddering attacks, benign paroxysmal torticollis, and benign paroxysmal vertigo. These conditions share episodic presentations but lack the characteristic hyperkinetic motor phenomenology and trigger patterns observed in PD.<sup>26,30–32</sup> Careful history-taking and clinical observation are essential for differentiation.

### Drug-Induced Movement Disorders

Drug-induced movement disorders, such as acute dystonic reactions or levodopa-induced dyskinesias, may present with abnormal movements resembling PD but are distinguished by their temporal relationship to medication use.<sup>7</sup> These are not primary paroxysmal disorders and should be excluded through a detailed medication history.

## Diagnostic Challenges in Sub-Saharan Africa

### Limited Access to Diagnostic Tools

The diagnosis of PD in Sub-Saharan Africa is significantly constrained by limited access to electroencephalography, neuroimaging, and genetic testing, which are often available only at tertiary centers.<sup>9,41</sup> As a result, clinicians frequently rely on clinical assessment alone, increasing the risk of misclassification, particularly in differentiating PD from epilepsy.

### Delays in Diagnosis

Delayed diagnosis is common, with reported intervals of several years between symptom onset and accurate diagnosis.<sup>9</sup> This delay reflects a combination of limited specialist availability, low index of suspicion, and prioritization of more prevalent neurological conditions such as epilepsy and infectious diseases.

### Consequences of Misdiagnosis

Misdiagnosis of PD as epilepsy carries substantial clinical and psychosocial consequences. Children are often exposed to long-term antiepileptic therapy with limited or no benefit, increasing the risk of adverse effects and financial burden. In addition, an epilepsy label may result in social stigma, educational restrictions, and reduced quality of life.<sup>26</sup> The failure to recognize PD also delays implementation of appropriate management strategies, including trigger avoidance and targeted therapies.

### Role of Caregiver-Recorded Videos

In the absence of advanced diagnostic tools, caregiver-recorded videos using mobile devices have emerged as a valuable adjunct for diagnosis. These recordings allow clinicians to directly observe attack phenomenology, improving diagnostic accuracy and facilitating differentiation from epileptic events.<sup>33</sup>

### Educational and Systemic Gaps

Systemic challenges, including limited training in movement disorders, scarcity of pediatric neurologists, and inadequate integration of neurology into primary healthcare systems, further contribute to under-recognition.<sup>9,41</sup> Addressing these gaps requires targeted educational interventions, development of simplified diagnostic algorithms, and increased use of telemedicine and regional collaborations to support clinical decision-making.<sup>34,39</sup>



## Management

### Non-Pharmacological Interventions

Management of PD in resource-limited settings emphasizes simple, effective, and low-cost strategies. Education of caregivers, teachers, and patients regarding the non-epileptic nature of the condition is essential to reduce stigma and prevent unnecessary restrictions. Trigger avoidance, including minimizing stress, ensuring adequate sleep, and avoiding known precipitants such as caffeine, is a cornerstone of management.

### Dietary and Lifestyle Measures

Dietary and lifestyle modifications are particularly important in PED and metabolically mediated forms. Regular meals, adequate hydration, and avoidance of prolonged fasting are recommended. In settings where formal ketogenic diet therapy is not feasible, modified dietary approaches using locally available foods may provide benefit, particularly in suspected *SLC2A1*-related disorders.<sup>35</sup>

### Pharmacological Treatment

Paroxysmal kinesigenic dyskinesia (PKD) demonstrates a remarkable response to low-dose anticonvulsants, particularly carbamazepine, with response rates exceeding 80–90%.<sup>36</sup> Effective control is often achieved at doses lower than those used for epilepsy. Oxcarbazepine is a suitable alternative, while phenytoin and valproate may be considered when first-line agents are unavailable or contraindicated.<sup>7,37,38</sup> In resource-limited settings, a therapeutic trial of carbamazepine may serve both diagnostic and therapeutic purposes. Paroxysmal non-kinesigenic dyskinesia (PNKD) shows variable responsiveness to pharmacotherapy. Benzodiazepines such as clonazepam may reduce attack frequency or severity in some patients, although avoidance of triggers remains the mainstay of management.<sup>6</sup>

Management of Paroxysmal exercise-induced dyskinesia (PED) focuses on lifestyle modification, including reducing exercise intensity, incorporating rest periods, and ensuring adequate nutrition and hydration.<sup>7</sup> Acetazolamide may be beneficial in selected cases, particularly when metabolic etiologies are suspected. Secondary PD requires identification and treatment of the underlying cause, such as metabolic disorders, structural brain lesions, or inflammatory conditions.<sup>7</sup> Targeted therapy may result in significant clinical improvement.

## Prognosis

Paroxysmal dyskinesias in children generally have an excellent prognosis, particularly primary forms, which are non-progressive with preserved neurological function between attacks. PKD often shows a reduced attack frequency with age, and many patients achieve partial or complete remission by adulthood, with excellent responses to carbamazepine or related agents.<sup>7,36</sup> PED associated with *SLC2A1* mutations frequently responds to dietary interventions,<sup>35</sup> while PNKD exhibits a more variable course. Early recognition and accurate diagnosis are critical to prevent misdiagnosis as epilepsy, unnecessary long-term antiepileptic use, and psychosocial stigma. Management combining pharmacological therapy, trigger avoidance, caregiver education, lifestyle modifications, and low-cost diagnostic tools such as caregiver-recorded videos or telemedicine optimizes outcomes. Strengthening clinician awareness, integrating PD into national pediatric neurology guidelines, and enhancing diagnostic capacity represent cost-effective, high-impact strategies to improve pediatric neurological care in resource-limited Sub-Saharan African settings.<sup>9,34,35,39,41</sup>

## CONCLUSION

Paroxysmal dyskinesias in children are frequently underrecognized and misdiagnosed as epilepsy in resource-limited Sub-Saharan Africa, driven by overlapping clinical features and constrained diagnostic capacity. This review highlights that accurate diagnosis is largely clinical and achievable through recognition of characteristic triggers, preserved consciousness, and normal interictal findings. Early identification enables effective, low-cost management and avoids unnecessary exposure to antiepileptic medications. Strengthening clinician awareness, integrating movement disorder training, and leveraging practical tools such as caregiver-recorded videos and telemedicine are essential. Improving diagnostic pathways and integrating paroxysmal dyskinesias into pediatric neurology frameworks will enhance outcomes and reduce the clinical and societal burden of misdiagnosis.

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# Readiness for Contributory Health Insurance among Civil Servants in Sokoto State, Nigeria: Implications for Reducing Out-of-Pocket Expenditure

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## ABSTRACT

**Background:** High out-of-pocket (OOP) healthcare expenditure remains a major barrier to equitable healthcare access in Nigeria, exposing households to financial hardship. The Sokoto State Contributory Healthcare Management Agency (SOICHEMA) was established to enhance financial risk protection; however, successful implementation depends on civil servants' readiness to participate. **Aim:** To assess awareness and knowledge of the Contributory Health Insurance Scheme (CHIS), willingness to participate, and healthcare financing patterns among civil servants in Sokoto State, Nigeria. **Materials and Methods:** A descriptive cross-sectional study was conducted among permanent civil servants across selected ministries using a two-stage sampling technique to recruit 250 participants. Data were collected using a pretested structured questionnaire and analyzed with IBM SPSS version 26. Descriptive statistics were used to summarize sociodemographic characteristics, awareness, knowledge, willingness to participate, and healthcare financing practices. **Results:** Of 250 questionnaires distributed, 239 were analyzed (response rate: 95.6%). Awareness of health insurance was high (96.2%); however, most respondents had poor knowledge of CHIS principles (72.4%), and only 32.2% were enrolled in any health insurance scheme. Willingness to enroll was high (82.8%), with 83.3% willing to enroll family members and a mean proposed monthly premium of ₦10,954. Out-of-pocket payment remained predominant (98.0%), with respondents reporting borrowing money (45.6%) or selling personal belongings (31.8%) to finance healthcare. **Conclusion:** Despite limited functional knowledge, civil servants demonstrated strong readiness for contributory health insurance. Strengthened health insurance education and accelerated implementation of SOICHEMA benefit packages are essential to translate willingness into enrollment and reduce OOP expenditure toward universal health coverage.

**Keywords:** Contributory Health Insurance Scheme, Civil Servants, Out-of-Pocket Healthcare Expenditure, Health Insurance Readiness, Universal Health Coverage

## INTRODUCTION

Sustainable healthcare financing remains a central pillar of the global pursuit of Universal Health Coverage (UHC), which seeks to ensure that all individuals receive necessary health services without financial hardship. Despite notable progress worldwide, financial protection against healthcare costs remains a major challenge, particularly in Low- and Middle-Income Countries (LMICs). The World Health Organization (WHO) estimates that approximately 150 million people globally incur catastrophic health expenditures annually, while over 100 million individuals are pushed into poverty due to direct out-of-pocket (OOP) payments for healthcare services.<sup>1</sup> These figures underscore persistent inequities in access to

healthcare and highlight the urgency of transitioning toward prepayment and risk-pooling financing mechanisms such as health insurance. Even in high-income countries with relatively advanced health systems, coverage gaps remain evident; for example, millions of citizens in the United States still lack adequate health insurance, demonstrating that financial risk protection is a universal health system concern.<sup>2</sup>

In many LMICs, healthcare financing remains heavily dependent on out-of-pocket spending (OOPS), which exposes households to unpredictable financial shocks during illness episodes. Evidence suggests that although

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some populations may accept user fees when associated with perceived quality healthcare services, reliance on direct payment at the point of care is inherently inequitable and financially unsustainable.<sup>3</sup> Consequently, health insurance schemes have emerged as a critical strategy for mobilizing resources, spreading financial risk, and improving equitable access to healthcare services. Assessing willingness to pay (WTP) for health insurance is therefore essential in settings where schemes must determine affordable premium contributions while maintaining financial sustainability and population acceptability.<sup>4</sup>

Global and regional studies demonstrate varying levels of readiness for contributory health insurance, depending on socioeconomic context, awareness, and trust in health systems. In Saudi Arabia, for instance, nearly 70% of respondents expressed willingness to contribute financially to national health insurance schemes, with higher income levels, urban residence, and education serving as significant predictors of enrolment.<sup>5</sup> Conversely, systematic evidence from Ethiopia and Sierra Leone indicates that limited awareness and inadequate understanding of insurance principles remain major barriers to participation, even where schemes are available.<sup>6</sup> These findings suggest that awareness alone may not translate into effective enrolment unless accompanied by adequate knowledge, perceived benefits, and confidence in scheme implementation.

Nigeria's health financing landscape is undergoing significant reform to achieve UHC through mandatory State Health Insurance Schemes (SHIS). The operational guidelines issued by the National Health Insurance Authority (NHIA) emphasize decentralized implementation through state-level contributory insurance programs that target both the formal and informal sectors.<sup>7</sup> The enactment of the National Health Insurance Authority Act 2022 further strengthened the legal framework by mandating financial risk protection for all Nigerians and promoting compulsory participation in health insurance schemes.<sup>8</sup>

Despite these policy advancements, empirical evidence across Nigerian states reveals considerable variation in awareness and preparedness for health insurance adoption. Studies among health workers and artisans have reported low awareness levels of approximately 28–29% in Ilorin and Abakaliki, respectively, indicating persistent informational gaps.<sup>9,10</sup> In contrast, investigations

conducted in Osun, Kaduna, and Port Harcourt documented high willingness-to-pay rates ranging from 82% to nearly 90%, suggesting strong latent demand for financial protection when confidence and understanding are adequate.<sup>11-13</sup>

Within this evolving national context, Sokoto State established the Sokoto State Contributory Healthcare Management Agency (SOICHEMA) to coordinate the implementation of a contributory health insurance program to reduce catastrophic household health spending and expand access to essential services.<sup>14</sup> However, experience from Nigeria and other LMICs demonstrates that health insurance schemes frequently encounter implementation challenges when administrative capacity, community trust, or stakeholder engagement is insufficient. Poor uptake, limited awareness, and weak population ownership have been identified as recurring causes of program underperformance and sustainability challenges.<sup>15</sup>

Civil servants constitute a strategic entry point for the successful implementation of contributory health insurance schemes because they represent a relatively stable, organized, formal-sector workforce with predictable income streams that are suitable for payroll-based premium deductions. Their participation often determines the early financial viability and public credibility of state health insurance programs. Despite the importance of this group, there remains limited empirical evidence regarding their readiness to transition from predominantly out-of-pocket healthcare financing to a contributory insurance model in Sokoto State.

Understanding civil servants' awareness, knowledge, perception of benefits, and willingness to enroll is particularly critical in a setting where OOP payments remain dominant, and households frequently resort to coping mechanisms such as borrowing money or selling assets to finance healthcare. Such practices reflect gaps in financial protection and highlight the potential role of health insurance in mitigating economic vulnerability associated with illness. Therefore, this study aims to examine the readiness for contributory health insurance among civil servants in Sokoto State, Nigeria, by assessing awareness and knowledge of the Contributory Health Insurance Scheme (CHIS), willingness to participate and enroll family members, and existing patterns of out-of-pocket healthcare expenditure. The study intends to provide policy-relevant evidence to guide effective



implementation of health insurance programmes, reduce financial barriers to healthcare access, and accelerate progress toward Universal Health Coverage in Nigeria.

## **MATERIALS AND METHODS**

### **Study Design, Population, and Area**

This study employed a descriptive cross-sectional design to assess readiness for participation in the Contributory Health Insurance Scheme (CHIS) among civil servants in Sokoto State, Nigeria. The study population comprised permanent civil servants working across selected ministries within the Sokoto State Civil Service who were actively enrolled on the state payroll during the study period. All eligible civil servants who provided informed consent were included in the study. Sokoto State is located in the North-West geopolitical zone of Nigeria and has a projected population of over 5.3 million. The state civil service workforce consisted of approximately 29,583 employees distributed across 28 ministries and government agencies. The study focused on civil servants, who constitute the primary target population for the formal-sector package of the Sokoto State Contributory Healthcare Management Agency (SOCHEMA), established in 2016 to coordinate the implementation of contributory health insurance in the state.

### **Sample Size Estimation and Sampling Technique**

The minimum sample size was estimated using Cochran's formula for single population proportion studies.<sup>16</sup> The calculation was based on a previously reported willingness-to-pay prevalence of 82% among similar populations,<sup>17</sup> a 95% confidence level, and a 5% margin of error. After adjusting for an anticipated 10% non-response rate, a final sample size of 250 respondents was obtained. A two-stage sampling technique was employed to select participants. In stage one, the 28 state ministries were stratified into three administrative clusters comprising the two major secretariats and other government agencies located outside the secretariat complexes. Two ministries were selected from each stratum using simple random sampling by balloting, resulting in six ministries (Health, Higher Education, Justice, Finance, Rural Development, and the Civil Service Commission). In stage two, lists of departments and staff strength within each selected ministry were obtained. Proportionate allocation of the sample size was performed across departments based on the number of eligible staff members in each ministry, and the

departmental staff lists were used to constitute the sampling frame. Eligible civil servants in the selected departments were then sampled systematically until the sample size allocated to each department was reached. Inclusion criteria included being a permanent civil servant on the state payroll and willingness to participate in the study.

### **Data Collection**

Data were collected using a pretested, structured, self-administered questionnaire adapted from previously validated instruments used in studies assessing awareness and willingness to pay for health insurance.<sup>18</sup> The questionnaire was designed to capture information relevant to readiness for contributory health insurance participation. The instrument consisted of four major sections: socio-demographic characteristics; awareness and knowledge of health insurance and CHIS; perception of benefits and attitudes toward contributory health insurance; and willingness to participate, willingness to pay premiums, and healthcare financing practices. Content validity was ensured through expert review by senior researchers experienced in health systems research and public health financing. The questionnaire was pretested among 25 civil servants (approximately 10% of the calculated sample size) at the Hospital Services Management Board, Sokoto State, who were not included in the final study population. Feedback from the pretest informed refinement of question clarity, sequencing, and internal consistency.

### **Data Analysis**

Completed questionnaires were checked for completeness and accuracy before data entry. Data were entered, cleaned, and analyzed using IBM SPSS Statistics (SPSS) version 26. Continuous variables such as age, monthly income, and proposed insurance premium were summarized using means and standard deviations, while categorical variables, including socio-demographic characteristics, knowledge level, awareness, perception, and willingness to participate, were summarized using frequencies and percentages. Knowledge of CHIS was assessed using a composite scoring system expressed as a percentage and categorized into poor, fair, and good levels based on predefined cut-off values. Results were presented using tables and charts.

### **Ethical Consideration**

Ethical approval for the study was obtained from the Department of Planning, Research, and Statistics of the

Sokoto State Ministry of Health. Administrative permission was also secured from the leadership of the selected ministries prior to the commencement of data collection. The purpose and procedures of the study were explained to all eligible participants. Written informed consent was obtained before enrolment. Participation was voluntary, and respondents were informed of their right to decline participation or withdraw at any stage without consequences. Confidentiality and anonymity were maintained by excluding personal identifiers from the questionnaires and restricting access to study data to the research team only.

## RESULTS

### Sociodemographic characteristics of respondents

Of the 250 questionnaires distributed, 239 were retrieved and analyzed, giving a response rate of 95.6%. The largest age group was 30–39 years (81; 40.5%), and the respondents were predominantly male (153; 64.0%). Most respondents were Muslims (224; 93.7%) of Hausa ethnicity (189; 79.1%), and the majority were male household heads (184; 77.0%). Educational attainment showed that the majority (226; 94.5%) had a tertiary education. Regarding grade level, the majority (127, 53.2%) were in grades 7–12 [Table 1]. The monthly income ranged from ₦30,000 to ₦750,000, with a larger proportion (98; 41.0%) earning ₦100,001 to ₦150,000 [Figure 1].

### Awareness, knowledge, and perception of the contributory health insurance scheme

A total of 230 respondents (96.2%) had heard about health insurance, while 188 (78.7%) had heard about the Contributory Health Insurance Scheme (CHIS). Only 77 respondents (32.2%) were enrolled in any health insurance scheme. Knowledge assessment showed that 173 respondents (72.4%) had poor knowledge, 66 (27.6%) had fair knowledge, and none had good knowledge. A total of 167 respondents (70.0%) reported that health insurance schemes were beneficial [Table 2].

### Willingness to participate and willingness to pay

Overall, 198 respondents (82.8%) were willing to enroll in CHIS, 199 (83.3%) were willing to enroll family members, and 168 (70.3%) were willing to enroll their entire household [Table 2]. Among respondents who specified the amounts they were willing to contribute ( $n = 132$ ), proposed monthly premiums ranged from ₦500 to ₦17,000, with a mean contribution of ₦10,954. A larger

proportion of respondents were willing to contribute ₦1,000–₦5,000 monthly (63; 47.7%), followed by those willing to contribute >₦10,000 monthly (33; 25.0%) [Figure 2].

**Table 1: Sociodemographic characteristics of respondents**

| Variables                 | Frequency (%) $n = 239$ |
|---------------------------|-------------------------|
| Age group (years)         |                         |
| 18-29                     | 29 (14.5)               |
| 30-39                     | 81 (40.5)               |
| 40-49                     | 55 (27.5)               |
| 50-59                     | 27 (13.5)               |
| 60-65                     | 8 (4.0)                 |
| Sex                       |                         |
| Male                      | 153 (64.0)              |
| Female                    | 86 (36.0)               |
| Religion                  |                         |
| Islam                     | 224 (93.7)              |
| Christianity              | 15 (6.3)                |
| Ethnicity                 |                         |
| Hausa                     | 189 (79.1)              |
| Fulani                    | 38 (15.9)               |
| Others                    | 12 (5.0)                |
| Household characteristics |                         |
| Male head                 | 184 (77.0)              |
| Female head               | 55 (23.0)               |
| Educational status        |                         |
| Primary                   | 2 (0.9)                 |
| Secondary                 | 11 (4.7)                |
| Tertiary                  | 226 (94.5)              |
| Grade level               |                         |
| 0-6                       | 29 (12.1)               |
| 7-12                      | 127 (53.2)              |
| ≥13                       | 83 (34.7)               |

### Healthcare financing practices

Out-of-pocket payment was reported by 234 respondents (98.0%) as the method of healthcare financing. Borrowing money to pay health bills was reported by 109 respondents (45.6%), while 76 (31.8%) had sold personal belongings to finance healthcare expenses [Table 2].

## DISCUSSION

This study examined the readiness for contributory health insurance among civil servants in Sokoto State, Nigeria, within the broader context of efforts to reduce out-of-pocket (OOP) healthcare expenditure and advance universal health coverage (UHC). The high response rate (95.6%) strengthens the internal validity of the findings and reflects strong engagement among respondents.

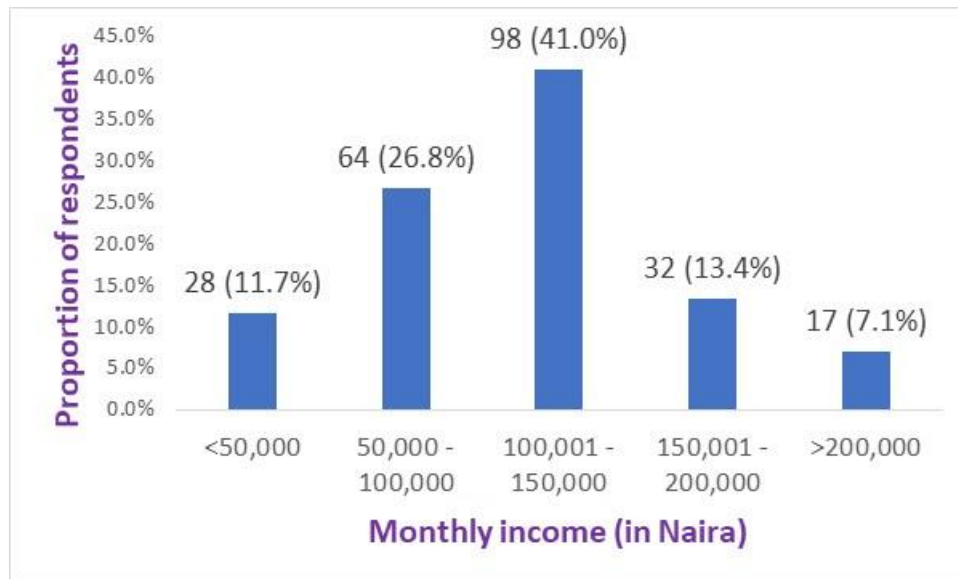
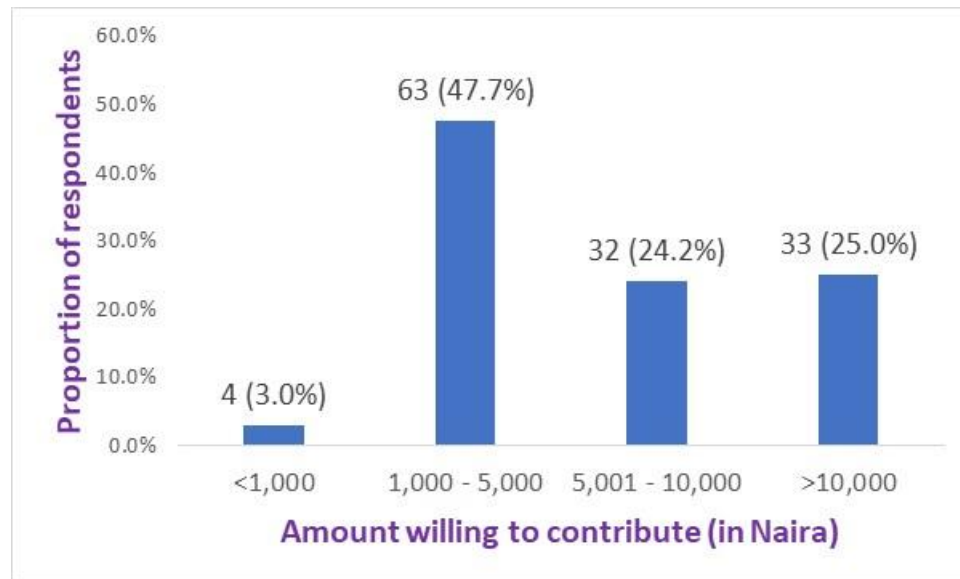


Figure 1: Distribution of respondents' monthly income

Table 2: Respondents' knowledge, perception, and willingness to enroll in the health insurance Scheme

| Variables                                                                  | Response, n = 239    |                     |
|----------------------------------------------------------------------------|----------------------|---------------------|
|                                                                            | Yes<br>Frequency (%) | No<br>Frequency (%) |
| Ever heard about health insurance                                          | 230 (96.2)           | 9 (3.8)             |
| Ever heard about the Contributory Health Insurance Scheme (CHIS)           | 188 (78.7)           | 51 (21.3)           |
| In a health insurance scheme                                               | 77 (32.2)            | 162 (67.8)          |
| Found benefits in health insurance schemes                                 | 167 (70.0)           | 72 (30.0)           |
| Willing to participate/enroll in the CHIS already established in the state | 198 (82.8)           | 41 (17.2)           |
| Willing to enroll some family members in the scheme                        | 199 (83.3)           | 40 (16.7)           |
| Willing to enroll the entire household in the scheme                       | 168 (70.3)           | 71 (29.7)           |
| Ever borrowed money to pay health bills                                    | 109 (45.6)           | 130 (54.4)          |
| Ever sold personal item(s) to pay for health/hospital bills                | 76 (31.8)            | 163 (68.2)          |



**Figure 2: Amount of money respondents were willing to contribute to CHIS**

The predominance of participants aged 30–39 years indicates a relatively young and economically active workforce, consistent with previous studies among civil servants and organized-sector workers in Abakaliki and Katsina States.<sup>10,19</sup> Such demographic characteristics are particularly relevant because younger working populations represent a strategic entry point for sustainable health insurance risk pooling, a core principle emphasized in health financing frameworks.<sup>3</sup>

The male predominance and overwhelmingly Muslim composition of respondents mirror the socio-cultural structure of North-Western Nigeria, where men often function as household heads and principal financial decision-makers.<sup>20</sup> The high proportion of respondents with tertiary education (94.5%) suggests a population theoretically well-positioned to understand health financing innovations. However, the findings reveal that educational attainment alone does not necessarily translate into adequate comprehension of health insurance systems. A key finding of this study is the marked discrepancy between awareness and knowledge of health insurance. Although almost all respondents had heard of health insurance (96.2%) and a substantial proportion were aware of the Contributory Health Insurance Scheme (CHIS), only a minority demonstrated fair knowledge, while none exhibited good knowledge. This pattern reflects what may be described as “nominal

awareness,” previously reported in Nigerian studies, where exposure to the concept of insurance did not equate to an understanding of risk sharing, premium contributions, or benefit entitlements.<sup>9,21</sup> The reliance on informal information sources rather than structured communication from implementing agencies such as SOCHEMA likely contributes to this gap.<sup>22</sup> Similar implementation challenges have been documented in community-based insurance programs across Nigeria, where inadequate public education limited enrollment despite favorable attitudes.<sup>15</sup>

Notably, actual enrollment in any insurance scheme remained low (32.2%), underscoring the persistent awareness–enrollment gap frequently observed in low- and middle-income countries (LMICs).<sup>8</sup> The finding suggests that legislative establishment of state insurance programs alone, including the SOCHEMA Law,<sup>14</sup> is insufficient to achieve coverage expansion without sustained demand-generation strategies. According to global UHC monitoring reports, effective insurance uptake requires not only policy availability but also trust, understanding, and perceived value among potential beneficiaries.<sup>1</sup> Despite limited knowledge, willingness to participate was remarkably high, with over four-fifths of respondents expressing readiness to enroll themselves and their family members. This level of willingness aligns closely with findings among civil servants in Kaduna State

and urban residents in Port Harcourt, indicating a growing acceptance of prepaid healthcare financing in Nigeria's formal sector.<sup>12,13</sup> The willingness to enroll entire households further highlights the central role of family protection as a motivating factor, consistent with economic theories of insurance demand that emphasize risk aversion and financial security.<sup>5</sup>

The mean proposed monthly premium of ₦10,954 suggests a substantial perceived value attached to health insurance among respondents. Given the income distribution and stable employment status of civil servants, this relatively high willingness to pay (WTP) may reflect both financial capacity and prior exposure to catastrophic health expenditures. Comparable studies in Ethiopia reported significantly lower WTP levels, underscoring contextual differences in income stability and perceived healthcare risk.<sup>6</sup> The findings therefore indicate that the formal public sector may serve as an initial anchor population for scaling state health insurance schemes, as recommended in Nigeria's National Health Insurance Authority operational guidelines.<sup>7</sup>

Healthcare financing practices observed in this study further explain the strong demand for insurance protection. Nearly all respondents relied on OOP payments, a proportion substantially higher than national estimates, where OOP expenditure already dominates health financing.<sup>4,24</sup> The widespread experience of borrowing money (45.6%) or selling personal belongings (31.8%) to pay medical bills illustrates the financial vulnerability associated with direct payment systems. Such coping mechanisms have been linked to delayed care seeking, impoverishment, and inequitable access to healthcare services.<sup>23</sup> These findings reinforce global evidence that high OOP expenditure remains a major barrier to achieving UHC and financial risk protection.<sup>1</sup>

Importantly, socio-cultural considerations may influence the transition from willingness to actual enrollment. In Northern Nigeria, misconceptions regarding insurance as speculative or religiously incompatible have previously limited uptake. Nevertheless, the strong willingness to enroll family members into the scheme observed in this study suggests that culturally framed messaging emphasizing collective protection and social solidarity may overcome resistance. Targeted, culturally sensitive communication strategies, combined with transparent benefit packages and efficient service delivery, are

essential to prevent the implementation challenges and user dissatisfaction reported in earlier Nigerian insurance programs.<sup>25</sup> Overall, the findings demonstrate that civil servants in Sokoto State exhibit substantial readiness for contributory health insurance, characterized by high awareness and willingness, but constrained by limited knowledge and low enrollment. Bridging this knowledge-participation gap through structured education, institutional trust building, and effective scheme implementation will be critical for translating willingness into sustained enrollment and ultimately reducing dependence on OOP healthcare financing.

## STUDY LIMITATIONS

This study has some limitations. Clarification of insurance concepts during data collection may have introduced interviewer influence, while religious and socio-cultural perceptions could have affected responses. The cross-sectional design limits causal inference, reflecting only associations at a single time point. The use of self-reported data introduces potential recall and social desirability biases, particularly for estimates of healthcare expenditure and willingness to pay. The study population, restricted to civil servants in selected ministries in Sokoto State, limits generalizability and may involve residual non-response bias. Furthermore, stated willingness to pay was hypothetical and may not translate into actual enrollment or sustained premium contribution.

## CONCLUSION

Civil servants in Sokoto State demonstrate strong readiness for contributory health insurance, with high awareness and willingness to enroll despite limited functional knowledge of the Contributory Health Insurance Scheme (CHIS). The widespread reliance on out-of-pocket payments and on financial coping strategies highlights the urgent need for effective financial risk protection. Bridging the gap between awareness and actual enrollment requires targeted health insurance education, culturally sensitive communication, and timely implementation of SOCHEMA benefit packages to build trust, promote household participation, and reduce out-of-pocket expenditure toward achieving universal health coverage.



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Nil.

### Conflict of interest

None declared.

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