



FEDERAL UNIVERSITY OF AGRICULTURE ABEOKUTA, NIGERIA

**FROM SAMPLE TO SOLUTION: HARNESSING STATISTICS FOR
EVIDENCE-BASED PUBLIC DECISION-MAKING IN THE DATA AGE**

BY

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PROTOCOL

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Members of my Immediate and Extended family,

All Special Guests and Friends of the University,

Gentlemen of the Press,

Distinguished Ladies and Gentlemen

Great FUNAABITES!!!

PREAMBLE

The Vice Chancellor Sir, it is with deep gratitude and humility that I stand before this congregation today to deliver this inaugural lecture, a milestone in every academic's journey, which is the 108th in the Federal University of Agriculture, Abeokuta (FUNAAB), the ninth from the College of Physical Sciences and second from the Department of Statistics. I thank the Almighty God for the grace to witness this day and for the gift of a fulfilling academic career. I extend heartfelt appreciation to the leadership of the Federal University of Agriculture, Abeokuta for the platform to teach, research, and serve, and to my colleagues for their collaboration and support over the years.

As a nation, and indeed as a global community, we are living in a data age, one in which information is not in short supply, but insight and application often are. Policymakers, now more than ever, are called upon to make decisions that are timely, evidence-based, and impactful

Today's lecture, titled **From Sample to Solution: Harnessing Statistics for Evidence-Based Public Decision-Making in the Data Age**, reflects not only the essence of my academic pursuit but also the evolving role of statistics in shaping the society. It is a story of transformation from numbers collected in households, farms, markets, and hospitals, to decisions that determine how public resources are allocated, how epidemics are managed, how poverty is measured, and ultimately, how lives are improved. It also answers the question of how we move from raw data to meaningful solution.

1.0 INTRODUCTION

Mr Vice- Chancellor, Sir, to fully appreciate the critical role that statistics plays in informing public decision-making, it is essential to begin by establishing a common understanding of the foundational concepts and key terminologies that will frame the discourse of this lecture.

1.1 Foundational concepts and key terminologies

Before delving into the application of statistics for evidence-based public decision-making, it is important to clarify certain foundational concepts and terminologies that underpin the discipline of statistics and its practical relevance. These concepts form the building blocks for understanding how data are collected, analyzed, interpreted, and translated into actionable insights.

1.1.1 *Sample*

In statistical terms, a sample is a subset of a population selected for analysis. It is the lens through which characteristics of larger groups inferred; be it a nation, a community, or an institution. Sampling allows statisticians and researchers to make evidence-based decisions without needing to measure every single element in the population. In everyday life, governments use samples to assess public health trends, evaluate school performance, and track economic indicators. These small segments, if correctly drawn and analyzed, yield insights that can transform entire sectors.

1.1.2 *Solution*

A solution in the context of this lecture refers to any action, policy, or decision that addresses a public challenge using evidence. Whether it is a new educational policy informed by a student learning survey, or a vaccination campaign driven by infection modeling, solutions are the ultimate goal of statistical inquiry.

1.1.3 *Evidence-Based Public Decision-Making*

Evidence-based decision-making is the systematic use of data and analytical reasoning to guide choices in governance. It requires that policymakers rely not only on ideology or pressure, but on tested, verifiable information to inform policies, allocate resources, and monitor progress.

As nations develop, evidence-based systems become increasingly crucial for transparency, efficiency, and accountability. In the Nigerian context, bridging the gap between data generation and policy implementation remains both a challenge and an opportunity.

1.1.4 *The Data Age*

The 21st century has ushered in what we now call the data age. Governments, organizations, and individuals generate data at unprecedented volumes. But without the proper tools to analyze and interpret these data, we risk drowning in numbers while starving for insight.

This lecture argues that statisticians, armed with principles of sampling, probability, and inference, are not just data analysts, but public problem-solvers.

1.2 **Development of Statistics from Evolution to Practice**

To fully appreciate the transformative power of statistics in the public sphere, we must look back at its journey, how statistical thinking evolved from mere headcounts to complex inferential systems that shape national destinies.

1.2.1 *Census Legacy and building Statistical Institution*

In Nigeria, formal statistical practice began in the colonial era, primarily for administrative convenience. Early censuses were tools of taxation and control, not instruments of development.

Though rudimentary, they laid the groundwork for modern statistical systems by introducing the concepts of enumeration, population coverage, and demographic analysis. The 1952/53 and 1963 population censuses marked significant milestones. Despite controversies, they demonstrated the power of data to influence political boundaries, revenue allocation, and governance structures.

Following independence, Nigeria recognized the need for a more structured approach to data collection. The establishment of the Federal Office of Statistics (now National Bureau of Statistics - NBS) in 1947 and its strengthening in the 1970s signaled a shift towards institutionalized data systems.

Statistical tools were increasingly used for planning, especially in agriculture, education, and health. Yet challenges such as inadequate funding, limited capacity, and political interference continued to constrain progress.

1.2.2 Global Influence, Modernization and Data Driven Governance

During the 1990s and 2000s, Nigeria became increasingly engaged in global statistical partnerships that significantly enhanced the country's data systems and analytical capacity. Prominent among these were the Demographic and Health Surveys (DHS), the Multiple Indicator Cluster Surveys (MICS), and the Living Standards Measurement Surveys (LSMS). These collaborations introduced robust sampling methodologies, standardized questionnaires, and frameworks for international comparability. Beyond improving data quality, they fostered a culture of evidence-based programming, particularly in critical areas such as health, nutrition, and child development. Through these global engagements, Nigeria aligned its statistical practices with international standards, paving the way for more reliable and policy-relevant data to inform national development strategies.

In more recent years, government ministries and donor agencies have increasingly embraced the use of data in program design, implementation, and evaluation. Tools such as dashboards, forecasting models, geospatial analytics, and real-time monitoring systems are becoming more prevalent, although their adoption across sectors remains uneven. We now operate in an era where national budgets are expected to be evidence-based, social interventions must be justified by data, and performance indicators determine international support and funding priorities. This evolution marks a fundamental shift in governance and development practice. It underscores the central message of this lecture, that statistics is no longer a mere technical or back-office function, but rather a core instrument for national progress, shaping how societies plan, allocate resources, and measure impact in the data-driven age.

2.0 CONTRIBUTIONS TO KNOWLEDGE

Mr. Vice-Chancellor, Sir, my research journey has been anchored on the belief that statistics must illuminate real-world problems and deliver actionable solutions. Guided by this vision, my work interconnects thematic areas that translate data into societal progress. These include:

- Statistical modelling for health outcomes,
- Educational measurement and learning analysis,
- Agricultural yield forecasting and food security modelling,
- Environmental and exposure risk analysis, and
- Aviation systems reliability and safety analysis.

2.1 Statistical modelling for health outcomes

My research in this domain has focused on leveraging statistical methodologies to address critical health challenges. Key contributions include the development of models for COVID-19 surveillance and control, analysis of malaria prevention strategies, assessment of heavy

metal toxicity among school children and radiological exposure and fertility differentials, providing valuable tools for public health monitoring and epidemiological planning.

2.1.1 Comparison of five models for assessing Patient Dose from Radiological Examinations

In collaboration with my colleagues, a study, *Comparison of Five Models for Assessing Patient Dose from Radiological Examinations*, was conducted (Olayiwola et. al, 2009). This work arose from a critical question in medical imaging: how can we accurately estimate the amount of radiation a patient receives during diagnostic X-ray procedures? and how do different mathematical models compare in doing so?

In radiology, every diagnostic image comes at a cost, exposure to ionizing radiation. The challenge is to ensure that while diagnostic information is maximized, patient radiation exposure remains as low as reasonably achievable. To address this, we compared five established models used globally to estimate patient doses during X-ray examinations. These models included the Davies model (taken as the reference), Faulkner model, Tung model, Edmond model, and Kepler model, each based on different assumptions about beam quality, tissue attenuation, and exposure geometry.

Datasets were randomly collected from two Nigerian hospitals; one state hospital and the private focusing on common diagnostic projections such as chest postero-anterior (PA) and lateral views, abdominal anterior-posterior (AP), and head and neck lateral radiographs. Using these clinical data, we calculated the Entrance Skin Dose (ESD) and converted them into Effective Doses (ED) using published conversion coefficients from the National Radiological Protection Board (NRPB) in the United Kingdom.

The results revealed striking numerical variations in patient radiation exposure across projections and hospitals. For example, the mean effective dose for chest postero-anterior radiographs was 0.01 millisieverts (mSv) in first (state) hospital and 0.08 mSv in the second (private). For chest lateral projections, the mean effective dose increased slightly to 0.11 mSv as shown in Figure 1. Abdominal anterior-posterior exposures were much higher, with patients at the first hospital receiving about 2.09 mSv, while those at the second had 1.56 mSv. For head and neck radiographs, the effective doses were 0.08 mSv and 0.06 mSv, respectively as shown in Figure 2.

To place these values in perspective, the NRPB's recommended reference dose for chest postero-anterior exposures in the United Kingdom is significantly lower. Our study found that Nigerian patients received at least 2.6 times higher doses for chest postero-anterior radiographs compared to the UK reference standard. Even more concerning, for paediatric head PA examinations, the effective dose was higher than both the NRPB reference and the adult dose by factors of 12.6 and 9.6, respectively. These values showed that patients in Nigerian hospitals were receiving radiation doses well above international safety benchmarks, potentially elevating their long-term risk of radiation-induced health effects.

When we compared the performance of the five models statistically, there were significant discrepancies between the reference Davies model and both the Faulkner and Tung models,

indicating that these two tended to estimate doses either higher or lower than the benchmark. However, there was no significant difference between the Davies model and the Edmond and Kepler models, suggesting that these latter models aligned closely with the standard reference approach as in Figure 2. Importantly, strong correlations were observed among four of the five models studied. This implied that in practical radiological dose assessment, any of these four models could reliably be used to estimate Entrance Skin Dose (ESD), the foundational parameter from which effective dose and risk are derived.

From a public health standpoint, the implications were sobering. The study clearly showed that patients examined in Nigerian hospitals were at a higher health risk than those in comparable facilities in the United Kingdom, owing to elevated radiation exposures.

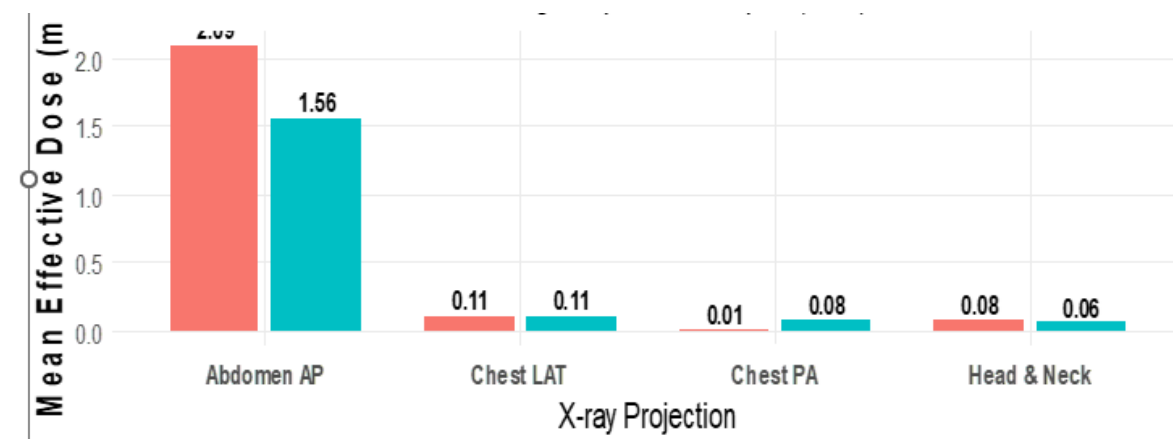


Figure 1: Mean effective radiation dose by X-ray projection

Source: Olayiwola et. al (2009)

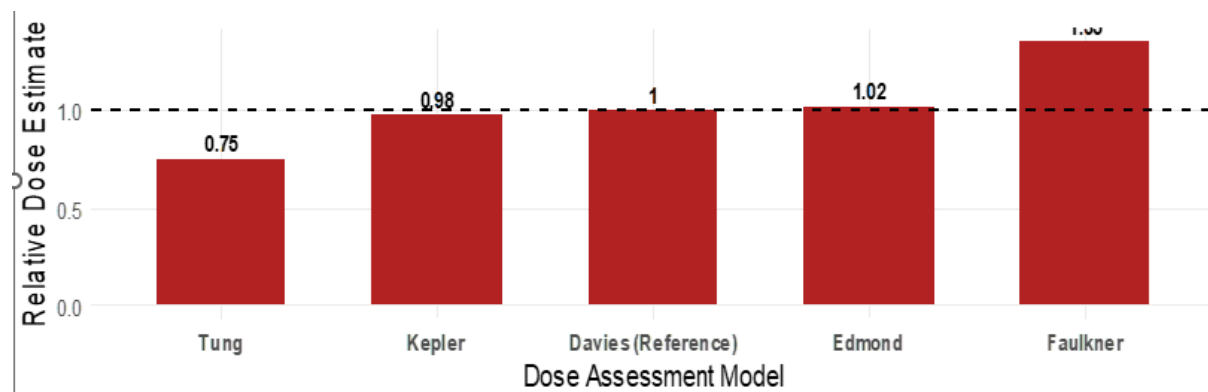


Figure 2: Comparison of dose estimation models

Source: Olayiwola et. al (2009)

2.1.2 Heavy Metal Burdens of Public Primary School Children Related to Playground Soils and Classroom Dusts

The growing concern about environmental exposure among school-aged children was critically examined in the study “Heavy Metal Burdens of Public Primary School Children Related to Playground Soils and Classroom Dusts in Ibadan North-West Local Government Area, Nigeria” (Olayiwola et. al, 2017). The study investigated the heavy metal burden among Nigerian children by analysing concentrations of Lead (Pb), Copper (Cu), Zinc (Zn), Iron (Fe), and Manganese (Mn) in playground soils, classroom dusts, and corresponding biological

samples. The results revealed that children attending urban schools had blood Lead levels almost twice as high as those from semi-rural areas, with Pb, Cu, Zn, and Fe concentrations in urban soils and dusts recorded at two to four times higher than those observed in semi-rural environments (Figure 3). A statistically significant positive correlation was also established between blood Lead and playground soil Lead concentrations, suggested that the school environment is a critical source of children's exposure to toxic metals. Lead was detected in the blood of all the age groups irrespective of sex (Figure 4). Both male and female school children in the age group 11–15 years had Lead levels that were almost two times more than their younger counterparts. No statistically significant difference was however observed between male and female in each age group in their blood lead concentrations ($p > 0.05$). Lead levels in urban children were twice as much as that of semi-rural children as shown in Figure 3. Zinc level in female children attending the semi-rural schools was 25% less than their counterparts in urban schools. Copper concentrations were not significantly different between the two groups. Although Fe and Mn levels were slightly lower in semi-rural children, these were not statistically significantly different when compared with their urban counterparts ($p > 0.05$). The study provided the first comprehensive evidence of school-based environmental contamination in Nigeria and highlighted the urgent need for regular environmental monitoring, improved school infrastructure, safer playground designs, and the implementation of effective public health policies to minimize children's exposure to hazardous metals within educational environments. With the exception of Lead where urinary excretion of Lead parallels that of the blood, urinary excretion of other metals was extremely low compared with their concentrations in the blood. There was an age-dependent increase in urinary excretion of Zinc in the female as well as Iron in the male. In each case, each older age group seems to excrete twice as much of the metal in urine than their younger counterparts. Playground soils and classroom dusts in urban schools seem to have similar Pb, Zn, Fe and Mn concentrations.

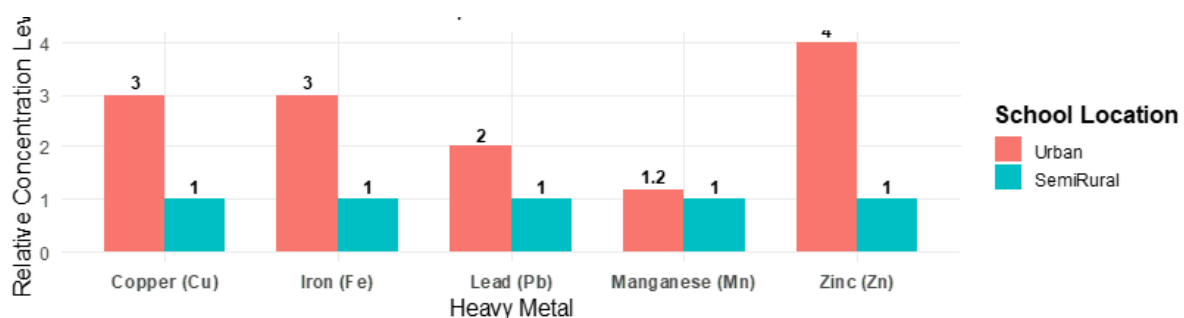


Figure 3: Environmental Heavy Metal Exposure in School settings
Source: Olayiwola et al. (2017)

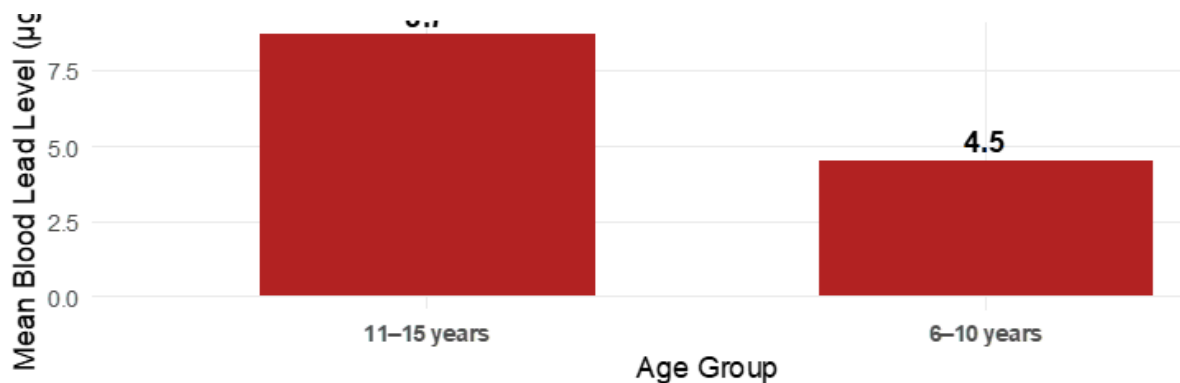


Figure 4: Blood Lead levels among school children

Source: Olayiwola et. al (2017)

2.1.3 Socio-Demographic and Behavioural Correlates of the Malaria Prevention Methods Utilized by Families of under-five Children Diagnosed with Malaria

The study, “Socio-Demographic and behavioural correlates of malaria prevention methods utilized by families of under-five children diagnosed with malaria at the Baptist Medical Centre, Saki” examined how educational background, occupation, income, and family practices shape the use of malaria prevention strategies among households caring for young children (Olayiwola et. al, 2016).

Four hundred and six children aged between six and fifty-nine months, along with their mothers or caregivers participated in the study. The male-to-female ratio was approximately 1.18 to 1, indicating a slightly higher representation of male children, and the average age of the children was 24 months. Mothers accounted for 79.3 percent of the respondents, confirming their primary role in childcare and health management within the family. In terms of family structure, 77.6 percent of the respondents were from monogamous homes while 22.4 percent were from polygamous households. The average age of the mothers was 31.2 years, while that of the fathers was 37.6 years, and this difference was statistically significant, reflecting the traditional age gap commonly found in many Nigerian families.

The educational profile of parents revealed that 37.4 percent of fathers and 33.3 percent of mothers had attained tertiary education, while approximately 30 percent of both parents completed secondary school. About 10 percent of both fathers and mothers had no formal education. These figures reflect the generally high literacy level of the southwestern region of Nigeria, which has historically benefited from early educational development. Trading was the dominant occupation among both fathers and mothers, engaging nearly half of the respondents. The average monthly income for fathers was ₦47,850, while mothers earned an average of ₦26,250. This significant income disparity highlights the persistent gender gap in economic opportunities, even among educated families.

Housing and environmental conditions also played a critical role in malaria prevention. Most families, about 43.8 percent, lived in flats, while 68.5 percent had window nets and 76.6 percent had door nets installed to prevent mosquito entry. Furthermore, 71.7 percent of households lived in well-cleared environments, showing a high level of environmental hygiene (Figure 5). Using the Oyediji social classification model, most respondents fell within social class III,

representing the middle socioeconomic group, while fewer belonged to the upper or lower classes.

Clinically, fever remained the most common presenting symptom among the children, either alone or accompanied by other symptoms. About 31 percent of children presented with fever only, 45 percent had fever with one other symptom, and around 8 percent showed non-febrile symptoms. A smaller percentage, 6.4, presented with febrile seizures (Figure 6). These figures confirm that malaria remains a leading cause of fever-related illness among children and emphasize the diversity of its clinical presentations. When parents were asked about their understanding of the cause of malaria, only 35.5 percent correctly attributed it to mosquito bites, while an equal proportion, 36 percent, confessed to having no idea. Others attributed it to causes such as teething, changes in weather, or even spiritual and dietary factors, reflecting the persistent cultural misconceptions that complicate the fight against malaria.

In terms of treatment-seeking behaviour, more than half of the respondents, 54.9 percent, gave some forms of medication at home before coming to the hospital, 23.2 percent did nothing initially, and about 6 percent used herbal concoctions. These behaviours underscore the reliance on self-medication and traditional remedies before seeking professional care, a pattern that often delays proper diagnosis and treatment. Regarding preventive practices, the most widely used malaria prevention strategy was the installation of nets on windows and doors, employed by 88.2 percent of families. The use of insecticide sprays was reported by 68.5 percent, insecticide-treated nets (ITNs) by 68 percent, and bush clearing around the house by 44 percent. Only a negligible proportion, less than 2 percent, relied on weeds or herbal repellents. Encouragingly, most families combined multiple preventive methods, indicating a growing awareness of integrated malaria prevention.

Awareness levels were generally high, with 89.4 percent of respondents aware of window and door netting as preventive methods, 85 percent aware of insecticide sprays, and 60.3 percent aware of ITNs. However, awareness did not always translate into actual usage, as financial limitations and misconceptions sometimes hindered full adoption. When asked whether malaria could be prevented, 60.8 percent agreed that it was preventable, 6.9 percent disagreed, and 32.3 percent were unsure, showing that a significant portion of the population still requires consistent health education and behavioural reorientation.

The statistical analysis using binary logistic regression revealed that three socio-demographic factors significantly influenced the use of recommended malaria prevention methods: the mother's level of education, the mother's occupation, and the father's monthly income. Specifically, the mother's education level was a strong predictor ($p = 0.012$), followed by her occupation ($p = 0.018$), and the father's income ($p = 0.053$), Figure 7. These findings illustrate that families with educated mothers were more likely to understand and practice malaria prevention correctly. Educated mothers also tend to have better decision-making power in household health matters. The mother's occupation, which contributes to household income, enhances her ability to purchase preventive tools such as insecticide-treated nets or insect sprays. Similarly, higher paternal income increases access to quality preventive measures and

timely medical intervention. Therefore, malaria prevention in children is not merely a medical concern but a reflection of educational empowerment and economic stability within the family unit.

Environmental care practices were also analysed. About 42 percent of the respondents cleared bushes and grasses around their homes, 30 percent swept their surroundings regularly, and 24 percent carried out general cleaning. Only a negligible 2 percent admitted doing nothing to maintain their surroundings. These figures highlight a fair level of environmental consciousness, though such practices need to be reinforced through community-based environmental management programmes.

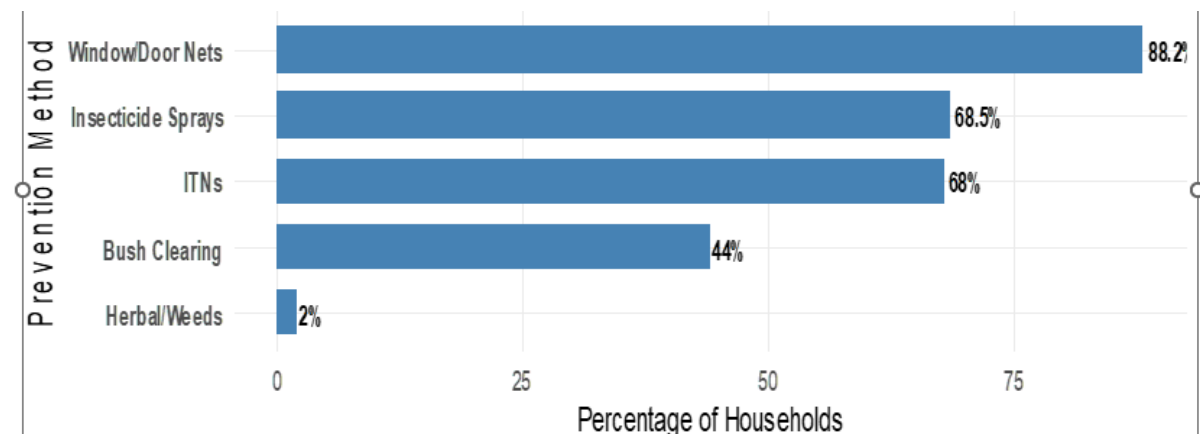


Figure 5: Malaria prevention practices among families of under-five children

Source: Olayiwola et. al (2016)

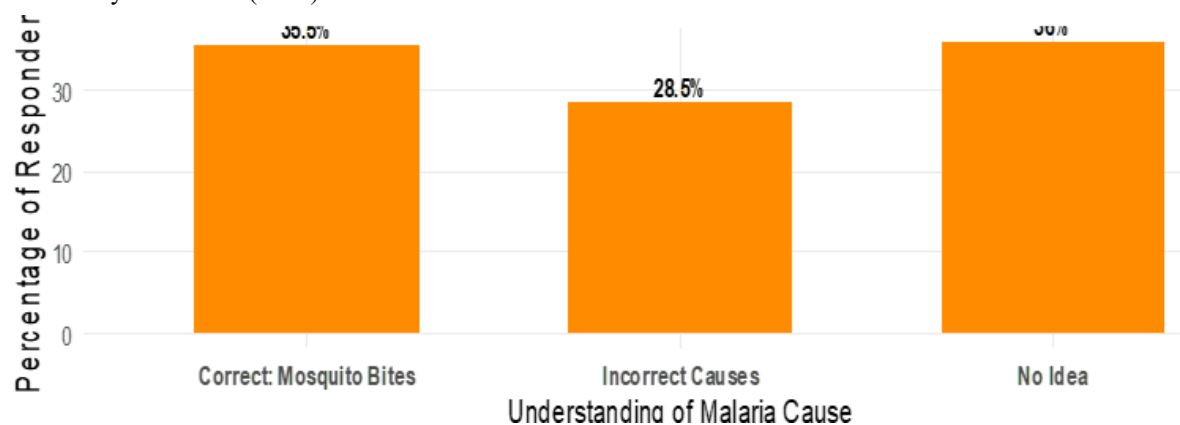


Figure 6: Knowledge of the causes of malaria among caregivers

Source: Olayiwola et. al (2016)

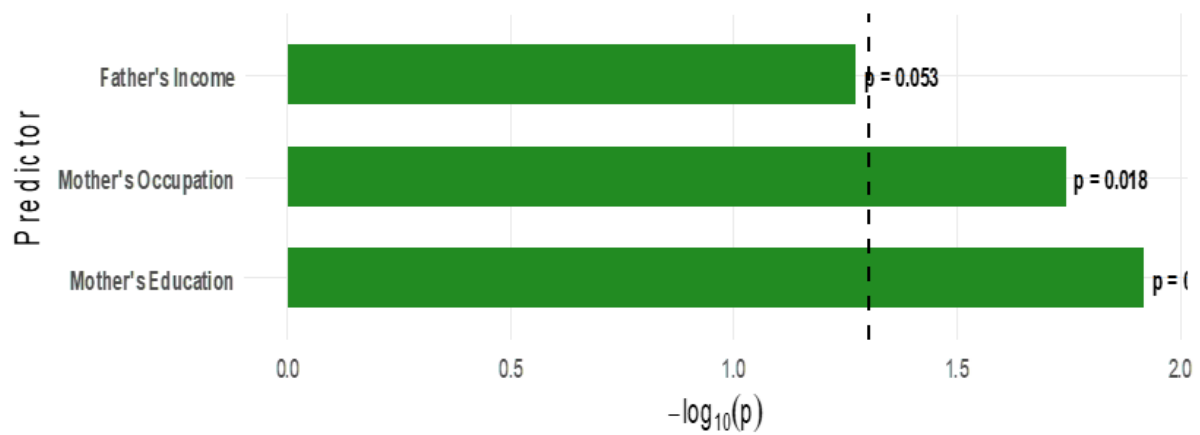


Figure 7: Socio-demographic predictors of malaria prevention use

Source: Olayiwola et. al (2016)

2.1.4 A Geographically Weighted Regression Approach to Examine the Dynamics of Fertility Differentials Across Africa

A continental-scale investigation into the persistent challenge of high fertility rates across Africa provided valuable insights into the demographic and socioeconomic factors influencing population growth. A *Geographically Weighted Regression (GWR) Approach* was used to examine the dynamics of fertility differentials across Africa Olayiwola et. al (2020). Spatial statistical techniques were applied to investigate variations in Total Fertility Rate (TFR) and its determinants among 53 African countries. The study tested for spatial autocorrelation using Moran's I index, which produced a positive value of 0.345 ($p < 0.001$), confirming that TFR values were spatially clustered rather than randomly distributed. This indicated that countries with high fertility rates were generally surrounded by others with similarly high rates, particularly across Middle and Western Africa, including Nigeria, Niger, Chad, Mali, Benin, Burkina Faso, and the Democratic Republic of the Congo.

Ordinary Least Squares (OLS) regression identified gross domestic product (GDP) per capita, contraceptive prevalence rate (CPR), and adolescent fertility rate (AFR) as the most significant predictors of fertility variation, explaining approximately 73.9% of the variability in TFR (Adjusted $R^2 = 0.739$; AIC = 99.90) (Figure 8). Recognizing that these relationships varied across space, the study advanced the analysis with a Geographically Weighted Regression (GWR) model, which improved explanatory power to 77.7% (Adjusted $R^2 = 0.777$; AIC = 90.4). The spatial analysis revealed that increases in GDP per capita were associated with declines in fertility, while higher adolescent fertility and lower contraceptive use were linked to higher TFR. Moreover, regional contrasts were striking: high adolescent fertility rates and low contraceptive usage exerted the greatest influence in Northern, Western, and Central Africa, while the negative impact of GDP per capita on fertility was most pronounced in Southern and Northern Africa.

Diagnostic assessments of the GWR residuals showed random spatial distribution (Moran's I = 0.036, $p = 0.276$), confirming the model's robustness. Local R^2 values, ranging from 0.743 to 0.776, demonstrated that the GWR captured local variations more effectively than the global OLS model. The results emphasized that fertility patterns in Africa are not uniform but shaped by geographically dependent social and economic processes.

The evidence suggested that countries in Middle and Western Africa remain the most influential in shaping continental fertility trends and therefore require intensified focus on adolescent reproductive health education, family planning accessibility, and economic empowerment of women.

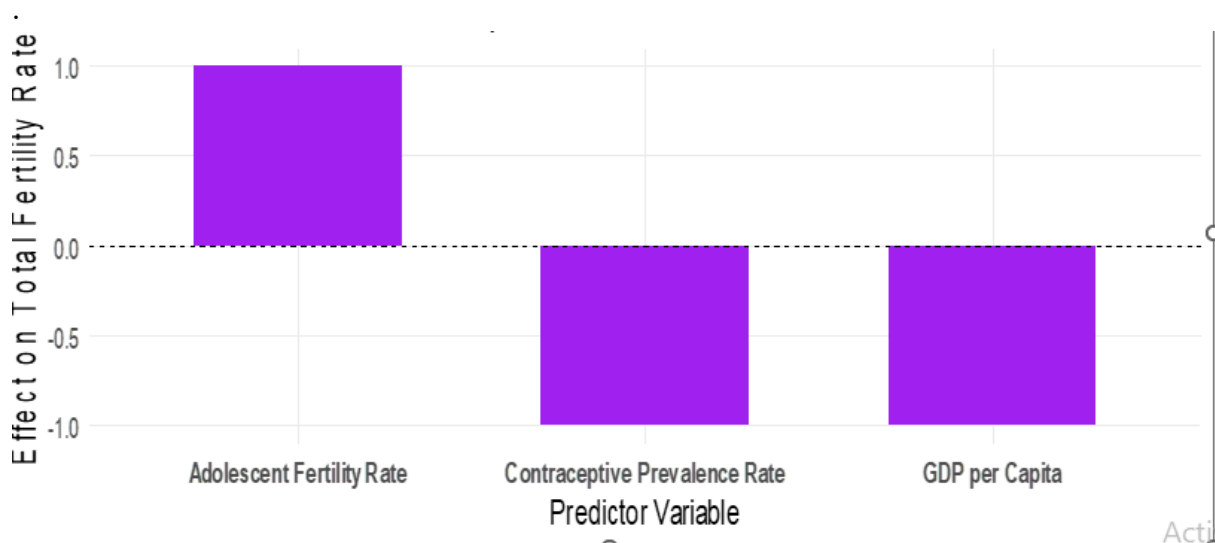


Figure 8: Key determinants of fertility across Africa

Source: Olayiwola et al. (2020)

2.1.5 Adaptive Cluster Sampling with Model-Based Approach for Estimating Total Number of Hidden COVID-19 Carriers in Nigeria

Olayiwola et. al (2020) contributed to public health analysis through the study of *Adaptive cluster sampling with Model-Based Approach for estimating the total number of hidden COVID-19 Carriers in Nigeria*. This work was conceived at the height of the COVID-19 pandemic, when traditional surveillance and contact-tracing methods were proving inadequate in identifying the full extent of infections across Nigeria. The study developed a Bayesian model-based adaptive cluster sampling approach to estimate the total number of hidden or unreported COVID-19 carriers in the population. By treating the spread of infection as a sparse but spatially clustered process, the model provided a more realistic framework for understanding how undetected cases contributed to community transmission.

Using daily case data from the Nigeria Centre for Disease Control (NCDC), the Nigerian population was partitioned into 37 administrative regions, the 36 states and the Federal Capital Territory, and analysed through Markov Chain Monte Carlo (MCMC) simulation. Diagnostic checks, including trace plots, kernel density estimates, and autocorrelation analyses, confirmed the reliability and stability of the model. The results revealed a consistent gap between confirmed cases and estimated true infections. For instance, on May 1, 2020, while NCDC reported 238 confirmed cases, the model estimated 289 carriers, leaving 51 undetected individuals still capable of spreading the virus. Similarly, on June 18, 2020, 745 confirmed cases were reported, but the model estimated 781 total carriers, implying that 36 infectious individuals remained unidentified (Figure 9). The findings demonstrated that the contact tracing strategy was insufficient for comprehensive case detection.

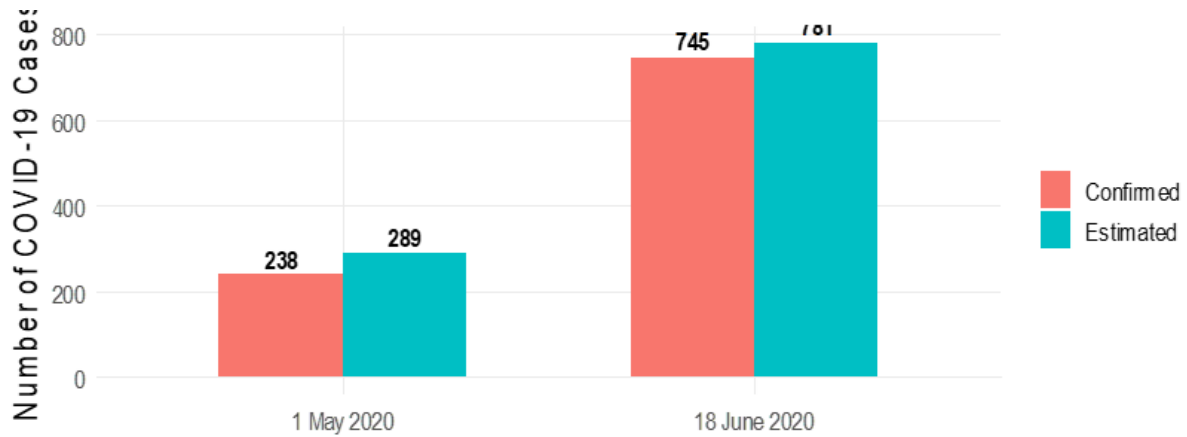


Figure 9: Observed versus estimated COVID-19 infectious in Nigeria
Source: Olayiwola et al. (2020)

2.1.6 Latent Gaussian Approach to Joint Modelling of Longitudinal and Mixture Cure Outcomes

Olayiwola et. al (2023) developed a *Latent Gaussian Model (LGM)* framework for the joint modelling of longitudinal and mixture cure outcomes. The approach provided an approximate Bayesian alternative that improved computational efficiency and inferential accuracy, especially for data exhibiting nonlinear trajectories and partial cure proportions.

The model was structured hierarchically, consisting of the data level (joint likelihood of the longitudinal and survival components), the latent level (a multivariate Gaussian structure for random effects), and the hyperparameter level (priors for variance and precision parameters). The longitudinal process captured the glomerular filtration rate (GFR), an important measure of kidney function, for 407 renal transplant patients. Using natural cubic splines allowed for the modelling of complex nonlinear trajectories in kidney function over time. The survival component combined a logistic model for the incidence of graft failure and a Cox proportional hazards model for the latency, thereby accounting for the presence of cured patients who did not experience failure within the study period. The Bayesian inference was performed using the Integrated Nested Laplace Approximation (INLA), which provided accurate deterministic posterior estimates and proved computationally superior to traditional Markov Chain Monte Carlo (MCMC) methods.

The mean GFR ranged between 40 and 50 ml/min/1.73m², with female patients generally showing lower GFR trajectories but higher survival probabilities compared to male patients (Figure 10). The estimated random intercept ($\sigma_{b10} = 205.113$, 95% CI: 181.523–233.550) and random slope ($\sigma_{b11} = 16.181$, 95% CI: 14.284–18.159) indicated significant patient-specific variability in both baseline kidney function and rate of decline. The association parameter ($\gamma = -0.109$, 95% CI: $-0.119, -0.100$) confirmed a strong negative relationship between GFR and the risk of graft failure, implying that patients with lower kidney function had a higher likelihood of transplant failure. Gender also showed males were found to have a 0.113 times higher risk of graft failure compared to females.

Model comparison using Deviance Information Criterion (DIC), Watanabe–Akaike Information Criterion (WAIC), and Conditional Predictive Ordinate (CPO) indicated that the spline-based model best captured the longitudinal pattern of GFR. Specifically, the spline trajectory yielded DIC = 512,648.7, WAIC = 511,513.9, and CPO = 259,609.95, compared to higher DIC values for the linear (528,069.6) and quadratic (579,324.3) specifications, thereby confirming its superior fit. The spline-based model successfully accounted for the nonlinear progression of kidney function and improved the prediction of survival outcomes.

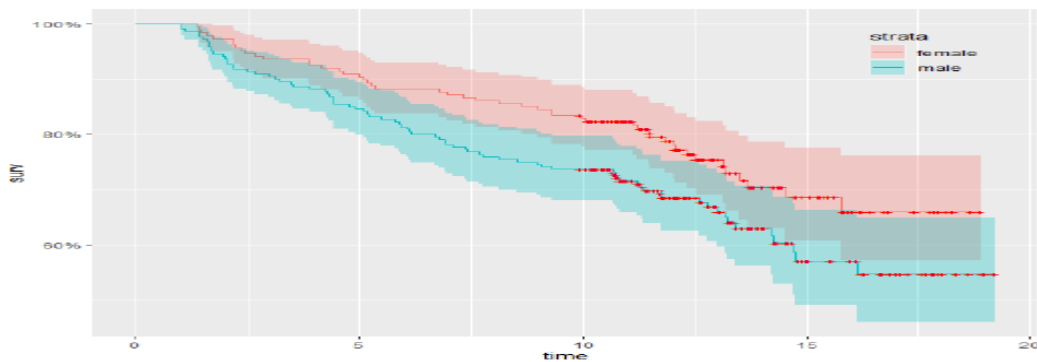


Figure 10. Survival estimates of patients according to gender of patients
Olayiwola et al. (2023)

2.1.7 Prediction models for Nigeria Neglected Tropical Diseases

In collaboration with colleagues, I led the development of Nigeria’s first predictive mathematical models for estimating ten-year reinfection probabilities of Neglected Tropical Diseases (NTDs). These models were developed and refined during a national workshop held in Abuja from December 10–14, 2025, with technical support from the Clinton Health Access Initiative.

The results showed that Lymphatic Filariasis reinfection risk remains low and well controlled across states. The mean reinfection probability was 0.02 with values ranging from 0.03 to 0.05. 75% of states recorded probabilities below 0.03, indicated limited spatial variation and sustained impact of mass medicine administration. Onchocerciasis has more variable reinfection risks. The mean ten-year reinfection probability was 0.05. Over 25% of states exceeded 0.05 reinfection probability. This heterogeneity reflects the complex ecology of Onchocerciasis. This work moves Nigeria’s NTDs modelling from descriptive prevalence assessment to predictive, forward-looking decision support.

2.1.8 A Centralized Machine Learning Dashboard as a Non-Medical Intervention for Early Detection, Monitoring, Prediction, and Management of Diabetes Complications

Diabetes is rapidly emerging as one of the world’s most critical public health challenges (International Diabetes Federation, 2025). Approximately 589 million people globally are living with diabetes, and alarmingly, 250 million remain undiagnosed. The disease often progresses silently, especially in its early stages, until it leads to serious complications such as kidney failure, heart disease, and premature death. The situation is particularly dire in low- and middle-income countries (LMICs), where 3 in 4 adults with diabetes are undiagnosed, and healthcare systems are frequently under-equipped to manage the rising burden. One in eight adults globally is at high risk of developing type 2 diabetes, and type 2 diabetes accounts for over 90% of all diagnosed cases. Individuals living with type 2 diabetes are at 84% higher risk

of heart failure, and more than 4 in 10 cases remain undiagnosed, resulting in missed opportunities for early intervention.

In Nigeria, the IDF reports that over 3 million people were living with diabetes in 2024, with an estimated 78.7% undiagnosed. This figure is projected to rise to 6.6 million by 2050. The global economic toll is equally alarming, with more than \$1.1 trillion spent on diabetes care in 2024 alone. Tragically, one person dies every six seconds due to diabetes-related complications. These figures illustrate an urgent need for a proactive, scalable, and technologically advanced approach to diabetes prevention and management.

My research addressed this need through the development of a Centralized Machine Learning Dashboard, a cutting-edge digital tool designed to revolutionize how we detect, monitor, predict, and manage diabetes complications. It integrated data from diverse sources and used machine learning algorithms to support clinical and policy decision-making in real time.

2.2 Improving Learning Outcomes and Educational

I explored the intersection of statistics and educational outcomes. My work includes analyses of students' academic performance, school enrolment estimation, evaluation of factors affecting CGPA and study behaviors, and the statistical modeling of performance predictors.

2.2.1 Using Multivariate Analysis to Identify Students at risk of academic failure in Nigerian Universities

One of the most significant contributions to the education sector was the application of discriminant analysis as a predictive and diagnostic tool for identifying students at risk of academic failure in Nigerian private universities. This work, titled "Efficiency of Discriminant Analysis in Identifying Performance of Students at Risk in Nigerian Private Universities" (Olayiwola et. al, 2015), demonstrated how statistical science can directly improve educational planning, student performance monitoring, and institutional efficiency. The research was motivated by the persistently high failure rates observed in science-based mathematical courses in several universities in southwestern Nigeria.

Randomly collected datasets from 1,622 science students drawn from three universities in Nigeria were analyzed to identify factors that best predicted students' performance. Fifteen potential predictor variables were initially considered, including WAEC and NECO results, cumulative GPA, gender, ethnic group and continuous assessment scores. The analysis revealed that only three variables, overall GPA, continuous assessment scores, and course-specific grades in Mathematics and Chemistry made significant independent contributions to predicting academic outcomes.

Among the students predicted to fail, the model correctly identified 319 out of 661, representing 48 percent accuracy for at-risk students, while it correctly identified 828 out of 961, or 86 percent, of students predicted to pass (Figure 11). The overall prediction accuracy was approximately 72 percent. When this model was tested on a new cohort, it retained its predictive strength, successfully identifying about 50 percent of students likely to fail and 84 percent of those likely to succeed, confirming its robustness and transferability across different

academic sessions. By leveraging existing student records, universities could now predict underperformance before it occurred, allowing timely intervention such as remedial classes, mentoring programs, or academic counselling. This predictive framework represented a shift from reactive to proactive educational management, where data-driven decisions could be used to prevent rather than merely record student failures.

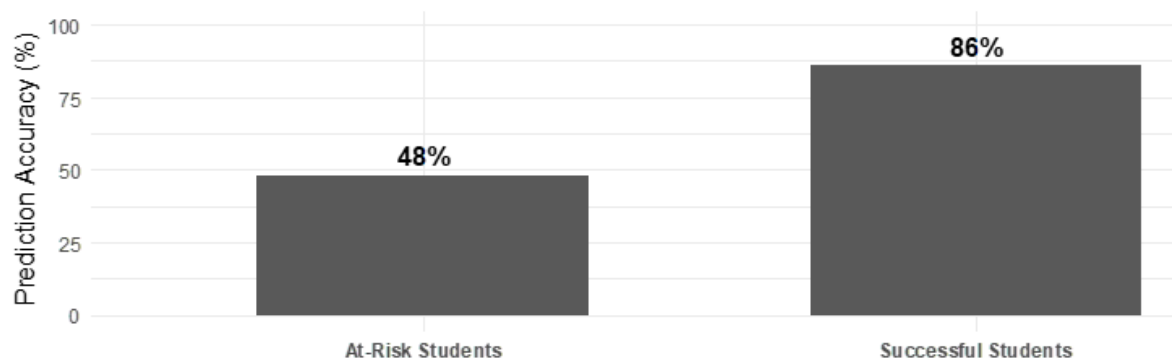


Figure 11: Discriminant model classification accuracy

Source: Olayiwola et al. (2015)

2.2.2 *The Effect of Daily Average Reading and Sleeping Hours on Students' Cumulative Grade Point Average (CGPA)*

Olayiwola et. al (2011) explored how the balance between study time and rest influences students' academic performance. The study involved 2000 randomly selected undergraduate students drawn from various departments, using data on their daily average reading and sleeping hours, along with their CGPA. Response Surface Methodology (RSM) model was employed to understand how these two lifestyle factors, study time and sleep duration, jointly affect students' academic results. The results revealed a positive relationship between reading and sleeping hours and students' CGPA.

Students who spend approximately four hours daily on focused reading and five hours sleeping after their normal lecture periods tend to achieve the highest CGPA (Figure 12). In practical terms, this means that academic excellence is best achieved not through excessive studying or prolonged rest, but through a balanced and disciplined schedule. Reading beyond four hours without rest did not translate to better performance. Instead, it led to fatigue and diminishing returns. Similarly, sleeping for longer than five hours after lectures was associated with lower academic outcomes due to reduced active study time.

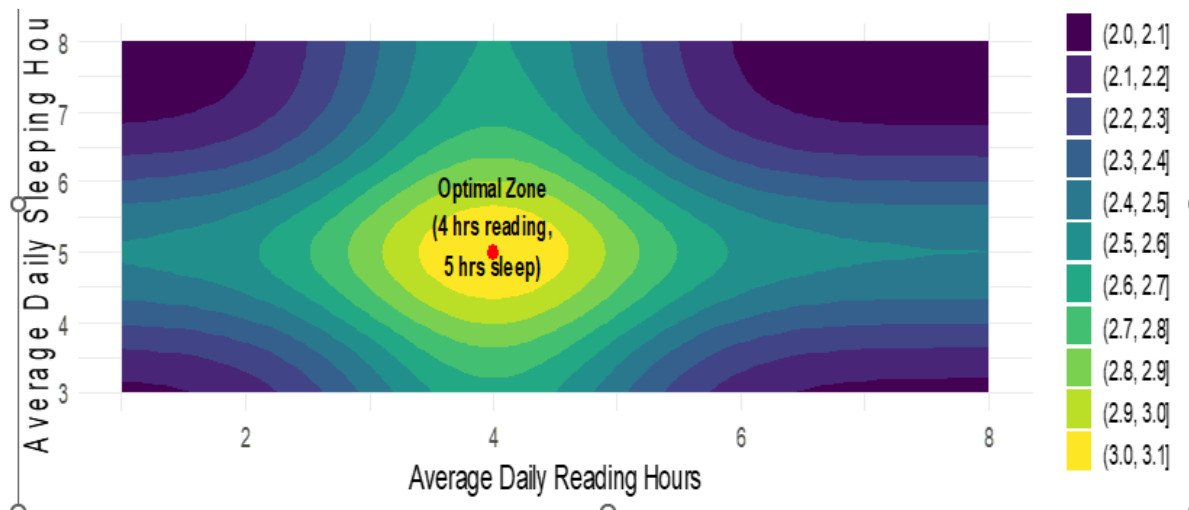


Figure: 12: Optimal Zone for joint effect of reading and sleeping hours on CGPA

Source: Olayiwola et al. (2011)

2.2.3 Double Sampling Approach for Comparing Estimates of students' Enrolment in Oyo State Public Secondary Schools.

The research on double sampling approach for comparing estimates of students' enrolment in Oyo State public secondary schools was a collaborative effort designed to provide more accurate and cost-efficient estimates of student enrolment trends across Oyo State using the principles of successive and double sampling (Olayiwola et. al, 2012). Education administrators frequently conduct enrolment surveys to monitor the number of students in schools across the state. However, when these surveys are repeated yearly, full enumeration becomes costly, time-consuming, and often unnecessary. Many schools remain the same, yet their enrolment figures change slightly. This realization provided the motivation for our research to determine whether using information from previous surveys could improve the accuracy of new estimates without the expense of starting from scratch each time.

Double sampling for regression estimation technique, which combines data from two occasions was employed. The first survey (or "occasion") and a second conducted later. The second sample was designed to include some schools from the first survey, the matched portion, and some newly added schools, the unmatched portion. In our study, out of 25 schools sampled, 17 were retained from the earlier survey (representing 68% of the sample, denoted by $\lambda = 0.68$), while 8 were new additions (32%, denoted by $\mu = 0.32$). This design allowed us to measure changes over time, estimate the current mean enrolment, compute the average over both periods, and determine how much information was gained from combining data across the two years.

For junior secondary schools, our computations yielded a current mean estimate of 6,372 students per local government area (Figure 13). This estimate, derived through regression adjustment, showed strong correlation between the two occasions, with a correlation coefficient of $\rho = 0.9225$, indicating a very high level of consistency between successive enrolment figures. The previous mean estimate stood at 6,482 students, giving a change of 110 students, or roughly a 1.7% decline. The negative sign of the change clearly indicates a drop in enrolment between

the two years under study, suggesting that fewer students enrolled or remained in junior secondary schools during the second year.

The variance of the junior category's current estimate was found to be 0.6215, and the minimum variance unbiased estimator (MVUE) further reduced to 0.4014, confirming improved precision when successive information was used. Importantly, precision increased as the correlation (ρ) approached unity, implying that the more similar the two survey occasions were, the smaller the error in estimating current enrolment. Statistical sensitivity analysis also revealed that precision was greatest when $\rho \geq 0.7$, particularly when μ (the fraction of new samples) remained below 0.32.

When we examined the average enrolment over the two occasions showed a mean of 12,823 students for the junior category. This figure, which represents the combined average of the two survey periods, is essential for long-term educational planning, as it provides a smoothed estimate that accounts for fluctuations in yearly enrolment. The gain in information, a measure of how much efficiency was achieved by using successive sampling rather than conducting two independent surveys was remarkably high at 238.98%. This means that by reusing part of the earlier sample, we achieved more than twice the amount of information at no extra cost, thereby demonstrating the practical value of double sampling in large-scale educational data collection. For the senior secondary schools, a similar approach was applied. The regression analysis produced a current mean enrolment estimate of 4,925 students per local government area, compared to a previous mean of 5,135 students, Figure 13. The difference of 210 students once again reflected a reduction in enrolment, possibly due to transition bottlenecks between junior and senior secondary levels, migration, or socio-economic factors affecting school retention. The correlation coefficient in this case was $\rho = 0.7385$, slightly lower than that of the junior category, indicating moderate stability between successive surveys.

The variance associated with the senior category's current estimate was 0.4896, while the optimized minimum variance dropped to 0.3289, confirming improved accuracy through the successive sampling process. The analysis of sensitivity patterns further showed that precision increased steadily for correlation levels above 0.7, validating the consistency of the method across both school levels. When the two surveys were combined to obtain an average enrolment over time, the estimated mean stood at 10,063 students. The gain in information from using common samples in this category was 45.37%, still significant though smaller than the junior category. This implies that the enrolment patterns at senior levels were more volatile, possibly reflecting student transfers, examinations, or early school leaving.

An important theoretical insight from the study was that minimum variance was achieved when the correlation coefficient (ρ) approached 1.0, meaning that the best precision occurs when the same schools are repeatedly surveyed and their enrolment patterns remain highly correlated over time. Conversely, when $\rho = 0$, the samples behave as independent, and no benefit is derived from matching samples. In such cases, the cost advantage of successive sampling diminishes. At $\rho = 1$ and $\lambda = 0.5$, the precision gain reached its peak, showing the optimal balance between retaining and replacing sample units.

Furthermore, the test for varying μ (the proportion of new schools) showed that small μ values and high p values produced the highest precision. This finding provides practical guidance to survey planners: where enrolment patterns are stable, it is statistically and economically beneficial to re-interview most of the previously sampled schools, introducing only a small fraction of new ones for representativeness.

Double sampling approach is not merely a mathematical exercise but a robust decision-support tool. By efficiently combining data from previous surveys with new data, education managers can monitor enrolment trends with fewer resources, while maintaining or even improving the reliability of estimates. The significant information gains, 239% for junior schools and 45% for senior schools, demonstrate that successive sampling substantially enhances data precision, particularly when enrolment figures are strongly correlated across years.

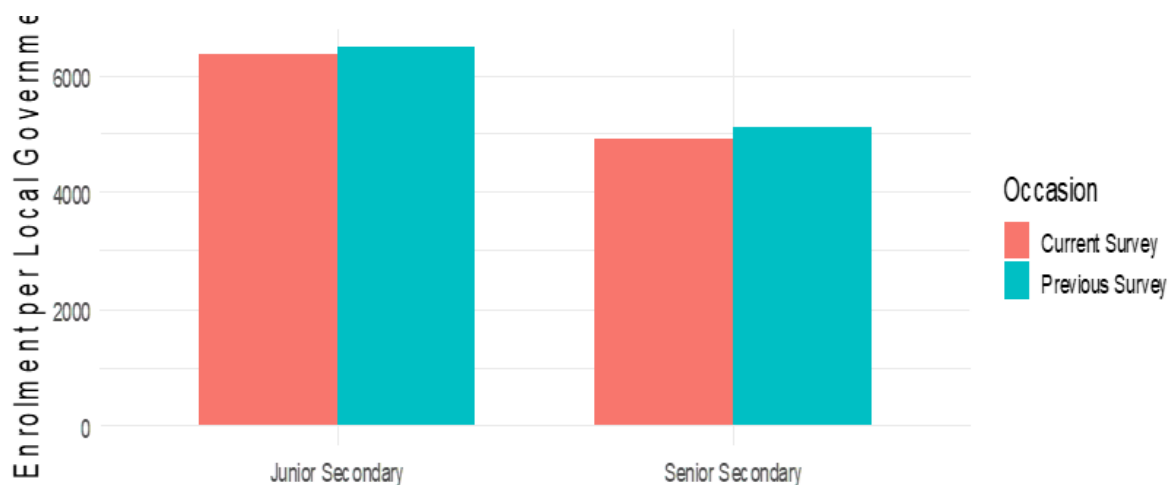


Figure 13: Comparison of students' enrolment across survey occasions for junior and senior secondary

Source: Olayiwola et al. (2012)

2.3 Agricultural yield forecasting and food security modelling

My research to Agricultural yield forecasting and food security modelling in Nigeria lies in the application of factorial design and Response Surface Methodology (RSM) to optimize the growth performance of broiler chickens fed with fluted pumpkin leaves extract (FPLE). A study was conducted on application of factorial design and response surface methodology on growth rate of broiler chickens served with fluted pumpkin leaves extract (Olayiwola et. al, 2012).

The use of fluted pumpkin leaves extract, a locally available, low-cost plant resource as a feed supplement to improve growth performance in broiler chickens was proposed (Olayiwola et. al, 2012). The extract, rich in iron, vitamins, and essential phytochemicals, was hypothesized to enhance weight gain and feed utilization efficiency. To test this hypothesis, an 8-week controlled experiment was conducted, involving 40-day-old Anak 2000 broiler chicks. The chicks were randomly distributed across five treatment groups receiving different concentrations of FPLE: 0 ml (control), 30 ml, 60 ml, 90 ml, and 120 ml per litre of drinking water, labeled A, B, C, D, and E respectively. Each treatment had four replicates, with two birds per replicate, and all birds were fed the same starter and finisher diets.

The data were analyzed using factorial design to study the main and interaction effects of number of weeks and quantity of FPLE on bird weight, and response surface methodology to

model the optimal combination of factors. The factorial analysis revealed that both the main effects and the interaction between treatment and weeks were highly significant ($p < 0.05$). The treatment effect yielded an F-value of 1,548.50 with a p-value of 0.000, while the week effect produced an even stronger F-value of 48,191.59 ($p < 0.000$). The interaction term between treatment and week was also significant with $F = 412.34$ ($p < 0.000$). The adjusted R-squared value of 0.999 indicated that the model explained nearly all the observed variation in weight gain, confirming that the factorial design was an excellent fit for the data.

The response surface model further revealed that the number of weeks, the quantity of FPLe, and their mutual interaction significantly influenced the weight of the birds. The model coefficients showed that each additional week increased body weight by 0.102 kg ($p = 0.006$), and each additional millilitre of FPLe contributed 0.014 kg ($p = 0.028$) to the bird's weight gain. However, the negative quadratic terms for both variables (-0.0049 for week^2 and -0.008 for FPLe^2) indicated a point of diminishing returns, suggesting that beyond certain thresholds, additional feeding time or excessive FPLe could lead to reduced weight gains.

A canonical analysis was performed to identify the stationary (turning) point of the response surface, revealing that maximum weight gain was achieved at 10 weeks of growth and 100 ml of FPLe per litre of water. This combination produced an optimum bird's body weight, as represented in the fitted canonical model. Both eigenvalues obtained (-0.0049 and -0.008) were negative, confirming that the stationary point represented a maximum rather than a minimum or saddle point. This result implies that the birds reached their highest weight when fed 100 ml of FPLe over a 10-week period.

The lack of fit test for the model yielded a p-value of 0.002, which, though statistically significant, indicated that the second-order model effectively captured the curvature in the data, justifying the use of RSM over a simpler linear model. The final R-squared value of 0.956 and adjusted R-squared of 0.8352 reaffirmed that approximately 95.6% of the variability in the birds' weight could be explained by the number of weeks and the quantity of FPLe. From a biological standpoint, these results confirm that FPLe supplementation enhances growth rate and overall body weight of broiler chickens. Birds fed with 30–120 ml FPLe consistently outperformed the control group, with those receiving 120 ml/L achieving the best growth performance during the 8-week period. The extract appeared most effective from the fifth week of age onwards, coinciding with the birds' active growth phase and increased feed conversion efficiency.

In practical agricultural terms, this study provides a cost-effective feeding strategy for small and medium-scale poultry farmers in Nigeria. By incorporating 100 ml of fluted pumpkin leaves extract per litre of drinking water into the feeding regime, farmers can achieve optimal weight gains of up to 4.56 kg per bird in 10 weeks (Figure 14), significantly improving profitability without relying on expensive synthetic growth promoters.

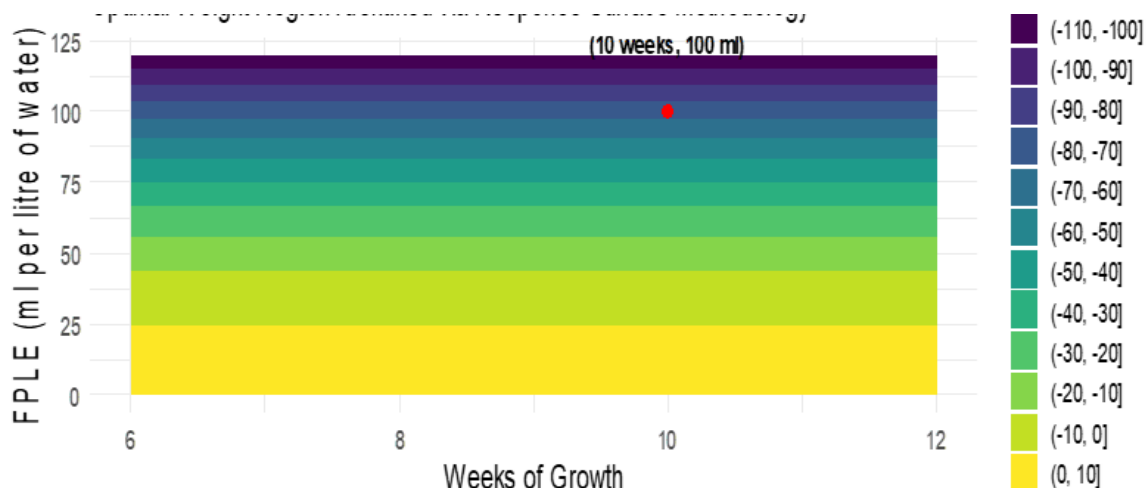


Figure 14: Optimal weight gains by the Broiler Chickens
Source: Olayiwola et al. (2012)

2.4 Environmental and Exposure Risk Analysis

In a study, “Vector Autoregressive Model for Monitoring Carbon Dioxide Emission from the Consumption of Fossil Fuels”, Olayiwola et. al, (2015) examined the relationship between Nigeria’s energy use and its environmental consequences, particularly the release of carbon dioxide (CO₂) into the atmosphere. Nigeria’s energy generation relies heavily on non-renewable sources, coal, natural gas, and petroleum all of which are fossil fuels that emit significant quantities of greenhouse gases when burned. The accumulation of CO₂ in the atmosphere is a major contributor to global warming, trapping heat that would otherwise escape into space and leading to climatic instability. The study investigated the trend of CO₂ emissions from these sources and developed a robust statistical model for monitoring the process over time. We obtained CO₂ emission data from the consumption of fossil fuels in Nigeria between 1980 and 2009, measured in million metric tons.

From the results, emissions from coal showed a declining trend, reflecting reduced use of coal as an energy source, while emissions from natural gas and petroleum showed steady increases over the same period, Figure 15. The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test for stationarity gave p-values greater than 0.05 for all three series; coal, natural gas, and petroleum implied the data became stationary after the transformation.

Vector Autoregressive (VAR) model was fitted to capture the interdependence among several variables evolving over time. Using the Akaike Information Criterion (AIC) and the Hannan–Quinn Criterion (HQ), we found that the model with one lag, known as VAR(1), provided the best fit for the data. This means that the CO₂ emissions in any given year were best explained by the emissions from the immediately preceding year, highlighting the persistence and continuity of emission patterns over time. For emissions from coal, the coefficient relating its current emission to its past value was 0.5475, which was statistically significant with a p-value of 0.004. This showed that about half of the variation in coal-related CO₂ emissions could be explained by its previous year’s emissions, a sign of temporal consistency in coal usage patterns. However, the effects of natural gas and petroleum on coal emissions were weak, with coefficients of -0.7529 and -0.8747, and both statistically insignificant. For natural gas, the picture was different. The coefficient for its own past value was 0.5587 with a p-value less than

0.001, indicating a strong self-persistence similar to coal. Petroleum emissions exerted a positive and significant effect on natural gas emissions, with a coefficient of 0.8472 and a p-value of 0.008, suggesting that increased use of petroleum was often accompanied by rising natural gas emissions, possibly due to joint industrial demand or overlapping energy infrastructures.

For petroleum, the autoregressive effect was stronger, its own past value had a coefficient of 0.5265, highly significant with a p-value below 0.001. This means that petroleum-based CO₂ emissions in one year are highly predictive of emissions in the following year, reinforcing the long-term dependence on petroleum in Nigeria's energy mix. The influences of coal and natural gas on petroleum emissions were positive but not statistically significant, with coefficients of -0.0240 and 0.0942, respectively. After fitting the model, diagnostic checks were performed to confirm its adequacy. The Portmanteau test for serial correlation produced a chi-square statistic of 77.79 with a p-value of 0.5805 indicating that the residuals were not serially correlated. In plain terms, this means that the model captured the dynamics of the system effectively and that no significant information was left unexplained.

Beyond this, we conducted the Wald test for Granger causality to investigate predictive relationships among the emissions from different energy sources. For emissions from coal and natural gas, the test yielded a chi-square value of 14.3 with a p-value of 0.0008, indicating a bidirectional causality, meaning that emissions from coal could be used to predict emissions from natural gas and vice versa. Similarly, between coal and petroleum, the test statistic was 12.1 with a p-value of 0.0023, also indicating mutual predictability. However, between natural gas and petroleum, the result was not statistically significant, with a chi-square value of 5.6 and a p-value of 0.062, suggested that changes in natural gas emissions do not directly predict changes in petroleum emissions, and vice versa.

From a policy standpoint, this study demonstrated the usefulness of Vector Autoregressive modelling as a tool for monitoring and forecasting environmental indicators. The VAR(1) model allowed us to simultaneously track and understand how CO₂ emissions from coal, gas, and petroleum influence one another, providing a dynamic framework for evaluating the impact of energy policies (Figure 15).

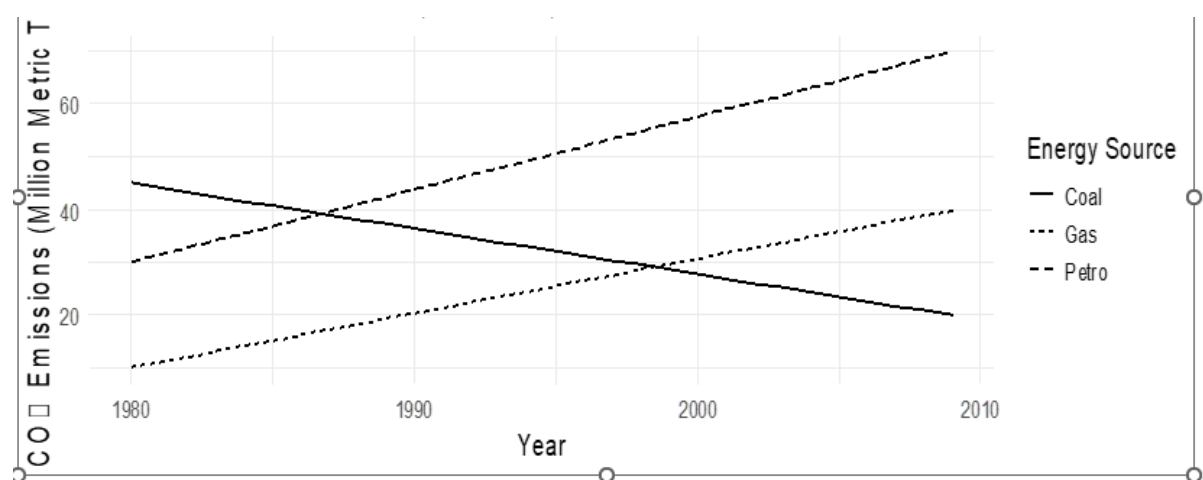


Figure 15: Carbon-dioxide emissions from fossil fuel consumption in Nigeria (1980 – 2009)
Source: Olayiwola et al. (2015)

2.5 Aviation Systems Reliability and Safety Analytics

Mr. Vice-Chancellor, Sir, one of the most vital areas where statistics silently saves lives is aviation. Modern aircraft rely heavily on electronic navigational systems, and even the smallest deviation in these systems can determine whether an aircraft lands safely or veers off course (Figure 18).

Olayiwola et. al, (2019) conducted the research to verify, monitor and strengthen the reliability of critical aviation technologies. The Instrument Landing System (ILS) is an essential radio navigation aid that assists pilots in aligning aircraft precisely with the runway during landing, especially in conditions of poor visibility (Figure 19). The ILS comprises three major components; the Localizer, which gives horizontal alignment; the Glide Path, which provides vertical guidance; and the Distance Measuring Equipment (DME), which measures range to the runway. Among these, our study focused on verifying the accuracy of the Localizer, the component responsible for keeping aircraft on the runway centerline. The Localizer operates by transmitting two overlapping radio beams, one modulated at 90 Hz and the other at 150 Hz, from an array of twelve high-gain dipole antennas installed at the far end of the runway. The point where both beams are equal in strength defines the centerline or equi-signal line, the invisible pathway guiding an aircraft to a safe touchdown. Any deviation in the strength of these signals is measured through a parameter called the Difference in Depth of Modulation (DDM), which indicates how far an aircraft might drift from the runway center.

The ground measurements were taken once every month for twelve consecutive months, covering both the dry and wet seasons, using the R&S EVS300 Analyzer, a precision instrument designed to capture radio signal variations with remarkable accuracy. The data was subjected to statistical analysis using GraphPad Prism version 5.01 to evaluate signal consistency and accuracy relative to international aviation standards.

The results showed that during the months of January, February, and May through September, the radiation from both the 90 Hz and 150 Hz sectors was found to vary only marginally. The mean DDM values recorded during these stable periods ranged from 0.0022 %/m to 0.0045 %/m, with specific averages of 0.0031, 0.0043, 0.0027, 0.0022, 0.0042, 0.0035, and 0.0045 %/m (Figure 16). These low values signify that the transmitted radio beams were virtually symmetrical about the runway centerline, indicating that the ILS localizer was performing optimally, allowing aircraft to align with the runway with high precision.

However, during the months of March, April, October, November, and December, the readings showed slightly higher deviations, with DDM values ranging between 0.028 %/m and 0.043 %/m (Figure 17). The highest deviation was recorded in March at 0.043 %/m, while the lowest among these months was in April at 0.028 %/m. Though these values indicated some asymmetry, suggesting that the electromagnetic waves from the 150 Hz sector were slightly stronger than those from the 90 Hz sector, they still fell well below the maximum allowable limit of 0.155 %/m set by the International Civil Aviation Organization (ICAO, Annex 10, Volume 1).

In practical terms, these results mean that even in months of minor signal distortion, the aircraft would not stray dangerously off course. The indicator needle on the pilot's display might shift slightly toward the right, reflecting stronger 150 Hz radiation, and the pilot would need to yaw

gently to the left to realign with the runway's centerline. Nevertheless, such corrections are minimal and routine in aviation, affirming the high precision and reliability of the ILS at this Nigerian international airport.

From a safety and engineering perspective, the minimum observed DDM was 0.003 %/m, and the maximum was 0.043 %/m, both substantially lower than ICAO's permissible error threshold. This indicates that the system maintained excellent signal integrity and met all global standards for navigational accuracy. This implies pilots approaching this runway could rely confidently on the electronic guidance system, even during challenging weather conditions or reduced visibility. Our analysis further revealed that the linearity of DDM variations remained consistent within $\pm 10^\circ$ of the runway centerline, beyond which deviations gradually increased but still remained well within safe operational limits. Between $\pm 10^\circ$ and $\pm 35^\circ$, the DDM values were below 0.0775, reaffirming that the electromagnetic beams were stable within the course sector, an indication of exceptional performance quality of the localizer.

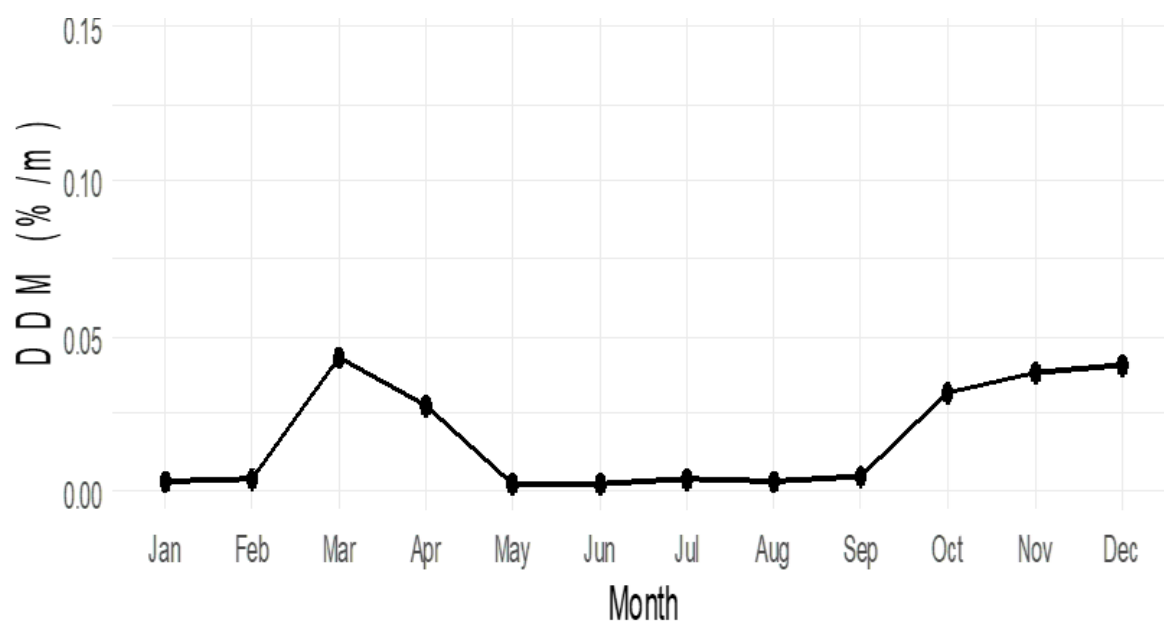


Figure 16: Monthly variation in ILS localizer difference in depth of modulation

Source: Olayiwola et al. (2019)

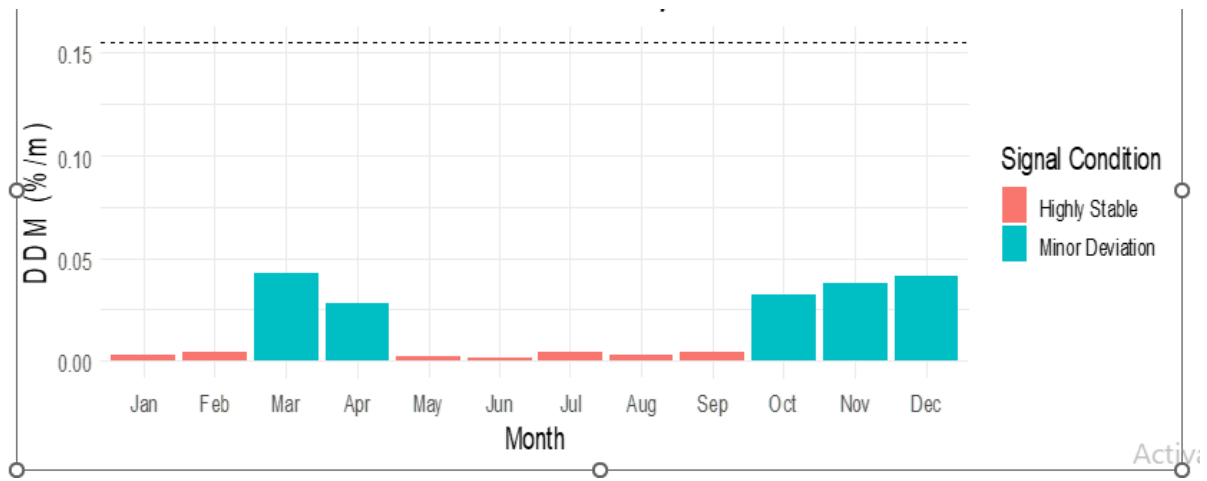


Figure 17: ILS Localizer accuracy by month
Source: Olayiwola et al. (2019)



Figure 18: A Landing Case Crash of Overland Aircraft on Fire at Lagos Airport, Nigeria (Daily Post, 2018)
Source: Olayiwola et al. (2019)



Figure 19: An Aircraft Landing on the Centerline of one of the Runways
Source: Olayiwola et al. (2019)

2.6 Statistical Theory and Methodology

A central pillar of my scholarly pursuit is the advancement of statistical theory. I have developed and refined estimation and sampling techniques, including work on stratified, adaptive cluster, and PPS sampling, as well as regression, ratio, jackknife, post-stratified, and calibration estimators. My efforts have also focused on survey methodology, longitudinal data analysis, and statistical inference, enriching the theoretical underpinnings of modern statistical science.

2.6.1 *Survey Response Across Various Levels of Response Predictors in Some Selected Communities in Oyo town, Oyo State, Nigeria*

The development and empirical validation of a framework for understanding survey response behaviour through the modelling of response predictors is one of my notable contributions to statistical theory and survey methodology, as detailed in the study “Survey Responses Across Various Levels of Response Predictors in Some Selected Communities in Oyo Town, Oyo State, Nigeria” (Olayiwola et. al, 2011). This work contributed significantly to the theoretical understanding of response dynamics, nonresponse bias reduction, and predictive modelling in social surveys.

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A two-stage stratified random sampling design was employed to select 750 households from 15 enumeration areas within Oyo town. Data collection was carried out over five waves of visits, with the aim of capturing both response and non-response dynamics over repeated contact attempts. Across the five waves, response counts were 545 (73%), 615 (82%), 610 (82%), 615 (82%), and 605 (81%) out of the 750 respondents per wave. These statistics revealed a clear pattern, response rates increased steadily from the first to the fourth visit but slightly declined on the fifth, suggesting diminishing returns to additional visits. This insight was crucial in providing empirical evidence for optimal survey contact strategies, highlighting that four callbacks were sufficient to maximize response rates in similar social contexts.

Incidence rate ratio (IRR) modelling was used to measure the relative likelihood of response across different predictor levels.

Results showed that family size exhibited a strong positive association with response rates. Using households without children as the reference category (IRR = 1.000), response rates were found to increase progressively with family size by 27% for families with one child (IRR = 1.27), 56% for two children (IRR = 1.56), 66% for three children (IRR = 1.66), 75% for four children (IRR = 1.75), and 84% for households with more than four children (IRR = 1.84). This indicated that larger households, possibly with more stable residency and stronger community integration, were more cooperative in surveys.

Similarly, the duration of interview had a substantial influence on participation quality. Compared to short interviews lasting less than five minutes (IRR = 1.00), those lasting 5–10 minutes showed a 23% increase in response (IRR = 1.23), while interviews extending to 11–15 minutes and beyond 15 minutes resulted in approximately 58% higher response rates (IRR $\approx$ 1.58). Respondents interviewed in English exhibited a 53% higher response rate (IRR = 1.53) compared with those interviewed in Yoruba, underscoring the cognitive and attitudinal influence of language choice on survey cooperation. Likewise, familiarity with the interviewer

increased the likelihood of participation by 21% (IRR = 1.21), confirming that social trust is a crucial determinant of respondent cooperation. Middle-aged respondents (51–70 years) were 94% more likely to respond (IRR = 1.94) compared to the younger cohort (30–50 years), while older respondents (71 years and above) were only 12% more responsive (IRR = 1.12). Respondents with secondary education were 27% more responsive (IRR = 1.27) than those with only primary education, while those with tertiary education were 54% more responsive (IRR = 1.54), Figure 21. Repeated contact attempts demonstrated that the probability of obtaining a response increased steadily up to the fourth visit, with IRRs remaining slightly above 1.00 up to four visits, but dropped drastically to 0.12 at the fifth visit, confirming that excessive callbacks may lead to respondent fatigue or irritation (Figure 22). Females were 15% more responsive than males (IRR for males = 0.85), aligning with existing social research that suggests women are more cooperative in survey participation. Tenants were 7% more likely to respond (IRR = 1.00 for tenants vs. 0.93 for homeowners), possibly reflecting higher community engagement or availability. Meanwhile, length of residence in a community had a significant positive effect: those who had lived for 6–10 years were 33% more likely to respond (IRR = 1.33), 11–15 years had 58% higher response (IRR = 1.58), and those with over 15 years of residence recorded 81% higher response (IRR = 1.81) compared to residents of less than five years. Finally, Nigerian nationals were 52% more responsive (IRR = 1.00) than non-Nigerians (IRR = 0.48), reflecting cultural and linguistic familiarity as enablers of cooperation.

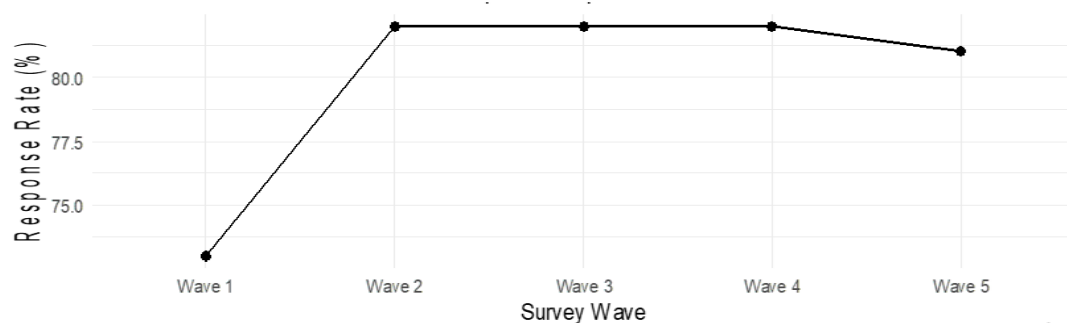


Figure 20: Survey responses across repeated contact

Source: Olayiwola et al. (2011)

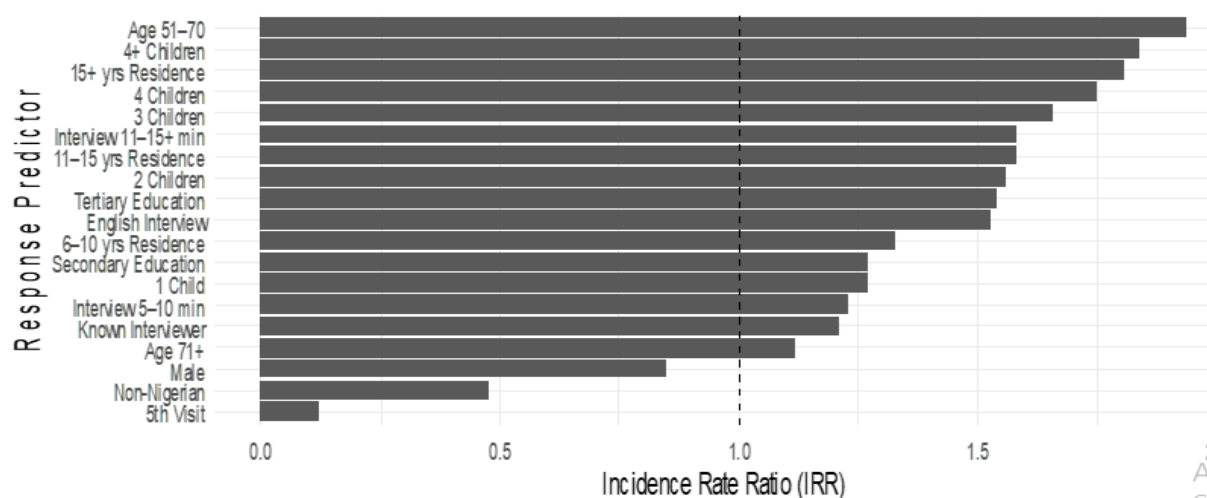


Figure 21: Incidence rate ratios for survey response predictors

Olayiwola et al. (2011)

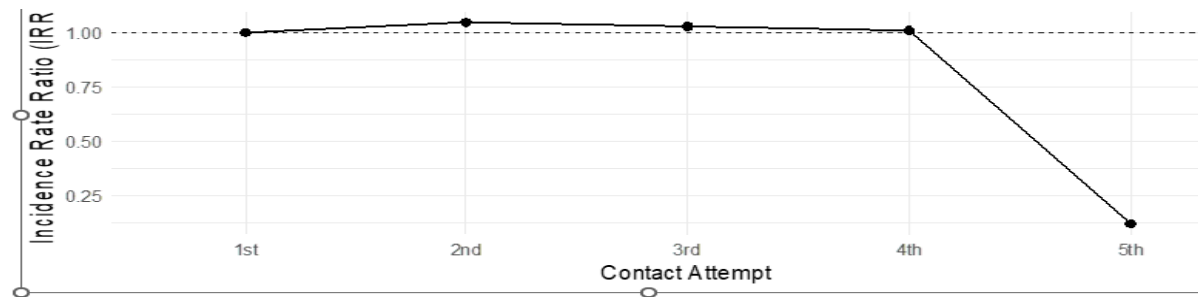


Figure 22: Effect of repeated contact on survey response

Source: Olayiwola et al. (2011)

2.6.2 Patterns of Refusals Conversion and Propensity of Converted Refusals to Respond at later Waves in a longitudinal Survey

I contributed to statistical theory through the development of improved models for understanding response behaviour and refusal conversion in longitudinal surveys. This work, “On Patterns of Refusals Conversion and Propensity of Converted Refusals to Respond at Later Waves in a Longitudinal Survey” provided new insights into how survey participants who initially refuse interviews can later be converted into respondents, and how their future participation can be predicted statistically (Olayiwola et. al, 2011).

The study was conducted using a two-stage stratified random sampling design in Oyo, Nigeria, with 750 households selected as sampling units. These households were followed over five consecutive waves, each representing a separate round of interviews conducted at six-month intervals. The purpose was to observe patterns of refusal, conversion success, and re-participation behaviour. Data were collected through structured oral interviews covering demographic and social variables such as age, gender, marital status, educational attainment, employment status, religion, and family size, as well as survey process indicators like duration of interview, language of administration, and interviewer familiarity.

At the first wave, 109 household heads participated, representing a response rate of 72.7%, with an average interview duration of 8 minutes. This initial wave experienced the highest level of refusals, which provided the foundation for modelling refusal conversion. Response rates improved in subsequent waves, 82% in wave 2, 81.3% in wave 3, 82% in wave 4, and 80.7% in wave 5, demonstrating the effectiveness of response maximization strategies such as advance notifications, flexible scheduling, and interviewer familiarity. Importantly, five household heads who initially refused interviews at Wave 1 were later persuaded to participate; two of these (40%) completed full interviews after conversion. Remarkably, all of them continued to participate in subsequent waves, maintaining 100% cooperation across later rounds. This finding provided empirical evidence that respondents who are successfully converted at an early stage can sustain participation over time, countering the assumption that refusal conversion yields only short-term compliance.

To formalize these findings, we employed logistic regression modelling to estimate the propensity of converted refusals to respond in later survey waves. Three models were constructed to capture different dimensions of response behaviour. The first model considered only the type of conversion, distinguishing between those converted to a full interview and those to a proxy interview.

Results showed that individuals converted to full interviews were 5.5 times more likely to participate in subsequent waves than those who had only provided proxy responses. When the timing of the conversion (i.e., the wave at which conversion occurred) and the duration since conversion were introduced into the second model, the findings revealed that conversions at the third wave produced the highest likelihood of continued response, approximately 3.8 times greater than those converted earlier or later. This indicated that respondent engagement builds progressively and that conversion at midpoints of panel surveys may yield more stable participation. In the third model, we incorporated demographic variables to better understand individual-level determinants of sustained participation. The results showed that male respondents were nearly three times (odds ratio = 2.94) more likely to continue participating after a conversion than females. Age also played a crucial role: those aged 30–50 years had the highest continued response rate, with an odds ratio of 3.45, compared with 1.64 for ages 51–70 and 2.21 for those above 70 years (Figure 23). Education further influenced response propensity, respondents with primary education were 3.18 times more likely to sustain participation than those with tertiary education, whose odds ratio was 1.94. This finding underscores the complex interplay between educational level and respondent fatigue, as highly educated respondents may be more selective or disengaged over multiple survey waves.

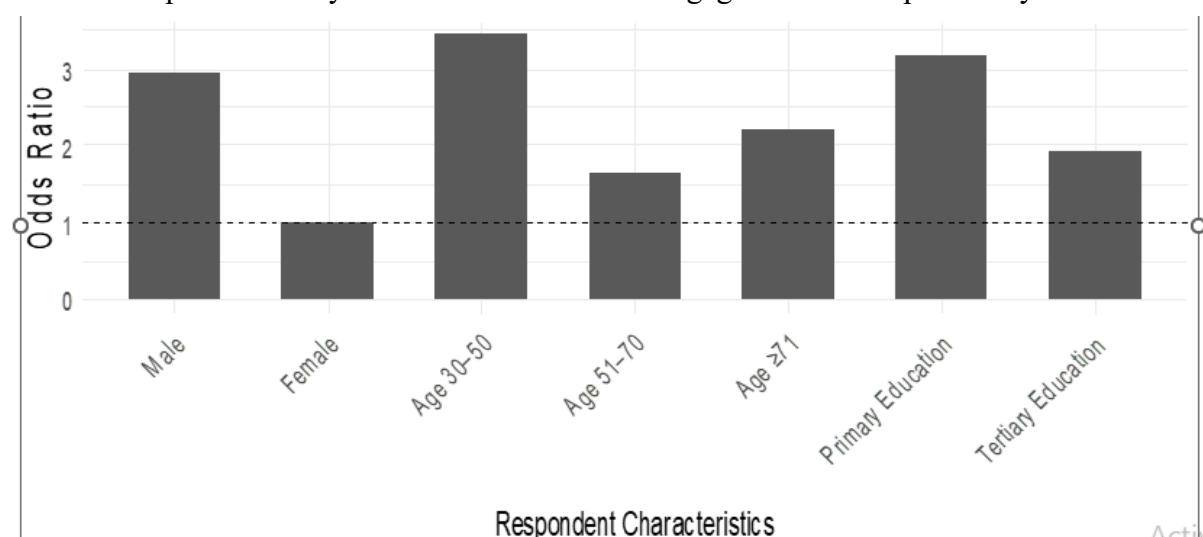


Figure 23: Determinants of sustained participation

Source: Olayiwola et al. (2011)

3.0 CONTRIBUTIONS TO HUMAN DEVELOPMENT

Mr Vice-Chancellor, Sir, my contributions to human development have been driven by a lifelong commitment to using statistical knowledge, research, and mentorship to uplift individuals, strengthen institutions, and advance society. Across the years, my efforts have centred on building people, shaping opportunities, and expanding capacities through teaching, mentoring, leadership, community engagement, and the creation of data-driven solutions that empower decision-making. These contributions reflect a deliberate investment in human capital, nurturing students and early-career researchers, supporting professionals across sectors, and providing evidence, tools, and systems that improve health, education, governance, and economic well-being. In this section, I present how these collective efforts have translated into tangible impact on human advancement at local, national, and international levels.

3.1 Teaching

I have taught and mentored students at both undergraduate and postgraduate levels for over a decade. My teaching philosophy emphasizes clarity, relevance, and practical application, ensuring that students not only understand theoretical concepts but can also apply them to real-world challenges.

At FUNAAB, I teach a wide range of courses including Survey Methods and Sampling Techniques, Statistical Inference, Distribution Theory, Experimental Design, Econometrics, and Analysis of Variance at undergraduate level. My teaching has consistently integrated modern statistical software such as R, SPSS, and Power BI, fostering analytical competence and digital literacy among students.

3.2 Student Supervision

In the last 19 years, I have supervised 120 undergraduate, 25 Masters, and five doctoral students in Statistics. These PhD graduates include Dr. (Mrs.) O. A. Wale-Orojo (Senior Lecturer, FUNAAB), Dr. I. O. Olawoyin, (Senior Lecturer, Aliko Dangote University), Dr. A. O. Ajayi (Lecturer I, FUNAAB), Dr. A. H. Ekong (Statistician I, Federal Medical Centre, Abeokuta), and Dr. Abiodun Olakiigbe (Statistician, Nigerian Institute of Medical Research). My supervisory philosophy emphasizes rigorous research design, methodological robustness, and strong societal relevance. I consistently encourage students to pursue research that addresses pressing local and global challenges, including public health modelling, agricultural data analytics, environmental risk assessment, and socioeconomic development planning. Many of my former students have progressed to careers as university lecturers, data scientists, policymakers, and international research fellows, thereby strengthening the visibility and impact of Nigerian scholarship within global research communities. Beyond technical training, I provide sustained mentorship on professional ethics, grant writing, publication strategies, and personal development.

3.3 Leadership

As Head of the Department of Statistics (2019 – 2023), I provided strategic leadership in academic planning, curriculum review, staff mentoring, and postgraduate programme expansion. I facilitated the integration of modern statistical software, strengthened research collaboration, and promoted student-centered learning within the department. At FUNAAB, I played a significant role in the review of the B.Sc. Statistics curriculum, aligning it with emerging global trends in data science, artificial intelligence, and computational analytics by introduction of the use of R software. Also, I am the current deputy dean, postgraduate school, FUNNAB.

At the national level, I contributed to the development of the Core Curriculum and Minimum Academic Standards (CCMAS) for Nigerian universities, coordinated by the National Universities Commission (NUC). This work ensured the inclusion of modern statistical computing, machine learning, and applied data analysis techniques in Nigeria's higher education framework.

Through these contributions, I have helped bridge the gap between theoretical instruction and the data-driven demands of the modern world, positioning students for global competitiveness and national impact

My leadership involvement extends beyond FUNAAB, as I have served as External Examiner for undergraduate and postgraduate programmes across several universities and polytechnics in Nigeria, including the University of Ibadan (UI), Obafemi Awolowo University (OAU), Federal University of Technology, Akure (FUTA), Federal University of Technology, Minna (FUT Minna), Olabisi Onabanjo University (OOU), and the Oyo State College of Agriculture and Technology (OYSCATECH).

At the professional level, as the Pioneer Chair of the Royal Statistical Society Nigeria Local Group (RSS-NLG), established in 2018, I led the establishment of a professional platform that unites statisticians across academia, government, and industry, promoting capacity building, professional networking, and advocacy for data-driven decision-making. I also serve as International Association of Survey Statistician country representative, Royal Statistical Society country representative, and Chair of DataNexa Services, where I coordinate training and consultancy initiatives that advance analytics and artificial intelligence applications.

I organized the inaugural RSS-NLG International Conference at the Federal University of Agriculture, Abeokuta (FUNAAB) in 2020, which attracted wide participation from academic, ministries and other government parastatals. I contributed to awareness of statistical literacy across the country through secondary school outreach programmes, advocacy initiatives, and professional training. At the National Bureau of Statistics (NBS), Abuja, I contributed to the modernization of national surveys, particularly the transition from manual to digital data collection (CAPI), and provided training in R, STATA, and SPSS software for staff members. I organized trainings on survey process, data collection, data analysis and the use of statistical softwares (R, SPSS and STATA) for Ogun State Bureau of Statistics, while at the Nigerian Institute of Science Laboratory Technology (NISLT), I facilitated training workshops on machine learning and AI-powered analytics, enabling laboratory scientists to improve their data interpretation and research reporting capabilities. Through these efforts, I have helped foster a generation of professionals equipped with the skills to harness data for effective governance, innovation, and national development.

In collaboration with colleague, we developed the first integrated predictive mathematical framework in Nigeria specifically designed to quantify reinfection probability in neglected tropical diseases (NTDs), with particular application to lymphatic filariasis and onchocerciasis. Building on multi-domain dataset from Federal Ministry of Health, encompassing treatment history, host and vector dynamics, ecological drivers, migration, insecurity, and behavioural exposure, we extended the classical SEIR model to explicitly incorporate treatment effects and loss of immunity. This innovation allowed us, for the first time in the Nigerian context, to formally model reinfection as a measurable and policy-relevant probability rather than an implicit assumption. The model, developed and refined during a national workshop hosted in Abuja with technical support from the Clinton Health Access Initiative. Using real programme data, we estimated a daily reinfection rate of $\rho = 0.0001$, corresponding to an annual reinfection probability of 0.036. By generating state-level reinfection probabilities and spatial risk maps,

this work moves Nigeria's NTD modelling from descriptive prevalence assessment to predictive, forward-looking decision support.

I have been privileged to contribute to two major United Kingdom funded interdisciplinary networks; the Past Earth Network (PEN) and the Maths Foresees Network at the University of Leeds, United Kingdom, both supported by the UK Engineering and Physical Sciences Research Council (EPSRC).

As part of my engagement with the Past Earth Network (PEN), a collaborative platform that unites statisticians, mathematicians, and climate scientists to harness data from past climates for understanding present and future climate dynamics, I contributed to scholarly discussions on spatio-temporal modelling, uncertainty quantification, and probabilistic climate reconstructions, with a focus on regions vulnerable to climatic variability.

In alignment with PEN's mission to promote global outreach and education, I organized and delivered a climate change awareness lecture at the Emmanuel Alayande College of Education, Oyo State, Nigeria, titled: "Anthropogenic and Natural Causes of Climatic Change – Effects, Management, and Modelling." The primary objective of the lecture was to raise awareness about climate change and emphasize the role of statistics in climate modelling and management, particularly among secondary and tertiary education communities. This initiative served as a bridge between academic research and societal engagement, aligning with the broader goal of promoting data-driven climate literacy in Nigeria. Similarly, the Maths Foresees Network focuses on applying mathematics and statistics to natural hazard forecasting and resilience building. Through this collaboration, I contributed to projects and workshops on environmental risk modelling, flood forecasting, and early warning systems.

4.0 CONCLUSION

Distinguished audience, esteemed colleagues, friends, and students, today's inaugural lecture has been a reflective exploration of how statistics transforms fragments of data into insights that drive national progress. It has demonstrated that when data are thoughtfully sampled, rigorously analyzed, and effectively communicated, they become far more than numerical records. They become strategic instruments for sustainable development, social transformation, and informed governance.

It emphasized the fundamentals of sampling, the essential bridge between populations and understanding. It highlighted how well-designed samples form the basis of credible evidence, enabling informed decision-making across governance, health, education, and agriculture. Through real-world illustrations, it showcased how adaptive designs, model-based estimators, and spatial analytical techniques have provided innovative solutions to complex challenges, from managing health crises and understanding fertility patterns to improving agricultural forecasting and strengthening institutional capacity. Statistical analysis was presented not as an end in itself but as a pathway to informed and impactful action. The discourse underscored that bridging the gap between statistical evidence and policy application requires clear communication, interdisciplinary collaboration, and institutional trust. It also reflected on the vast opportunities and emerging challenges of the data age.

It has drawn deeply from both theoretical frameworks and personal academic experiences gained through years of teaching, research, and public service. The contributions presented stem from a lifelong dedication to building statistical capacity, fostering data literacy, and promoting evidence-based decision-making, especially in contexts where data exist but are underutilized, and where the voices of the marginalized are often overlooked.

5. 0 RECOMMENDATIONS

Mr. Vice-Chancellor, Sir, based on the body of evidence presented in this inaugural lecture, the following recommendations are proposed for targeted implementation by key stakeholders, with the aim of translating statistical innovation into measurable national impact.

National development planning should explicitly incorporate predictive statistical models, such as spatial regression, Bayesian adaptive sampling, and time-series monitoring to anticipate risks rather than respond reactively.

Longitudinal survey protocols should be redesigned to optimise response efficiency, limiting excessive callbacks while strategically applying refusal-conversion techniques.

Environmental exposure studies involving children and vulnerable groups should be routinely conducted, with findings translated into school-based and community-level interventions.

Universities should deploy predictive academic analytics to identify students at risk of failure early and implement targeted interventions such as mentoring, remedial teaching, and academic counselling.

Data from aviation monitoring systems should be archived and analysed longitudinally to support predictive maintenance and risk prevention, rather than periodic compliance checks alone.

Locally available agricultural resources should be scientifically evaluated using statistical optimization techniques to enhance sustainable and affordable farming practices.

Stronger academia–industry–government partnerships should be fostered to ensure that statistical research translates into national development outcomes.

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