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RESISTANCE TO ARTEMISININ-BASED COMBINATION THERAPIES (ACTS) AMONG PATIENTS: CHALLENGES AND STRATEGIC APPROACHES FOR MITIGATION

ETIM, John John[1*]; EFEJENE, Israel Ofejiro[2]; IBU, Josephine Moshe[3]; EKPO, Ekpo Iyamba[4]; OTALI, Cyril Chinedu[5]; ETIM-JOHN, Obasesam John[6]; AGBIJI, Nneka Ndifon[7]; & IDEM, Iboro Ekaette[8]

[1]*Health Services Management and Health Policy Unit, Department of Public Health, Faculty of Allied Medical Sciences, College of Medical Sciences, University of Calabar, Nigeria*

[2]*Department of Pharmacology, College of Medical and Health Sciences, Novena University, Ogume, Delta State, Nigeria*

[3]*Department of Nursing, School of Allied Health Sciences, Miva Open University, Abuja, Nigeria*

[4]*Department of Radiography, College of Health Technology, Calabar, Nigeria*

[5]*Department of Biological Sciences, Novena University, Ogume, Delta State, Nigeria*

[6]*Department of Radiography and Radiological Sciences, University of Calabar Teaching Hospital, Nigeria*

[7]*Environmental Health Unit, Department of Public Health, Faculty of Allied Medical Sciences, College of Medical Sciences, University of Calabar, Nigeria*

[8]*Department of Pharmacology and Toxicology, Faculty of Pharmacy, University of Calabar, Nigeria*

Corresponding author: Etim, John John; University of Calabar Nigeria, Email: etmjhn@gmail.com; Tel: +2348063809268

Abstract
Artemisinin resistance delayed parasite clearance following treatment with conventional ACT regimens. This may result from poor drug compliance on the patient's part, poor quality of the drug or patient re-exposure to the parasite. The study investigated the rate of ACT resistance among patients and possible approaches to combat it. The study adopted a descriptive cross-sectional study design and laboratory examination of patients' blood for malaria parasites. The questionnaire was used to elicit data from 2,720 respondents and 70 participants were used for the laboratory blood test using rapid test kits. Data were analyzed using descriptive statistics. The study showed that 1,397 (51.36%) were females and 1,160 (42.65%) were males with prescriptions based on hospital visits from March 2020 to July 2021. The majority 820 (30.45%) were within the age bracket of 21-30 years. The various dosage forms observed were IM injections, tablet forms and some pediatrics suspensions. Co-prescribed antibiotic drug ciprofloxacin 176 (23.31%) as mostly prescribed, Azithromycin followed with a frequency of 132 (17.48%), with clarithromycin 8 (1.06%) having the lowest frequency. There is evidence of ACT resistance among patients used in the study. Irrespective of the type of ACT prescribed, there are usually resistances due to factors like non-completion of treatment, poor quality of the ACT, and re-exposure to the parasite. It is recommended that patients should be encouraged to complete their treatment, prescribers should always check for the efficacy of the ACT before making it available to patients and non-pharmaceutical approaches should be encouraged to avoid re-exposure to the parasite.

Keywords: ACTs resistance, Patient, Malaria parasites, Antibiotics, Plasmodium falciparum

Introduction

Nigeria's National Malaria Control Programme (NMCP) has been following a specific plan since 2008. Its objective is to reduce 50% of the malaria burden by 2013 by ensuring that at least 80% of homes in targeted areas have long-lasting impregnated mosquito nets (LLINs). Other measures include treating all pregnant women who visit antenatal care clinics with two doses of intermittent preventative therapy (IPT) and providing indoor residual spraying (IRS) to 20% of houses in targeted areas (Ye et al., 2012). Due to these efforts, the proportion of families with at least one LLIN rose from 5% in 2008 to over 70% in 2010 (Garley et al, 2013). Malaria and its burden were to be prevented, controlled, and eradicated. In nations like Nigeria where it is widespread, malaria continues to be a major source of sickness and mortality for both adults and children. The worldwide initiative to "Roll back malaria" is seriously threatened by the growing resistance of

Plasmodium falciparum malaria. Sulphadoxine-pyrimethamine (SP) and chloroquine are becoming less and less effective, which raises morbidity and death as well as the financial and social expenses. Artemisinin-Based Combination Therapies (ACTs) are therefore advised by the World Health Organization as a first-line treatment for uncomplicated malaria (WHO, 2016; 2018).

The sub-African region may be resistant to ACTs, according to recent findings. With some of the available ACT antimalarials being prescribed, there is not enough pertinent data to support this assertion. Examining how doctors prescribe ACT anti-malarial drugs in private hospitals and how patients finish their prescriptions is essential to addressing the threat of ACT drug resistance because non-completion of these medications indicates abuse, which is often a major contributor to resistance (Balikagala et al., 2021). Testing for resistance requires a precise laboratory diagnosis because false-negative results could lead to untreated malaria and potentially lethal consequences. Both clinical faith in test results and the reputation of a community's health services could be severely harmed by false-negative results. Parasitological confirmation of malaria is crucial for case management and accurate malaria burden assessment (Watson et al., 2019). Regardless of age or the environment of transmission, WHO has advised since 2010 that all suspected cases of malaria be verified parasitologically by microscopy or Rapid Diagnostic Tests (RDTs) prior to treatment? When confirmatory tests are not available or are known to be of low quality, this guideline is broken (WHO, 2016). For the most vulnerable demographics, such as young children and non-immune individuals, accurate diagnosis is especially crucial in malaria-endemic areas. Antimalarial medication treatment can enhance the detection of other feverish disorders in all contexts. To raise the standard of care and surveillance, the World Health Organization fervently supports a testing, treatment, and tracking policy.

The rapid diagnostic test (RDT), malaria microscopy, and obvious clinical manifestation are the three procedures that can be used to make the diagnosis (WHO, 2016; 2018). Treatment failure is the primary effect of antimalarial medication resistance. There are no early treatment failures at low resistance levels, but the percentage of patients experiencing late recrudescence rises. Recrudescence happens sooner and earlier as resistance levels grow, and eventually, with high-grade resistance, parasitaemia either doesn't clear up or, worse, keeps getting worse (White, 2004). A slowdown in the removal of parasites is a sign of growing resistance. Slow parasite clearance, which indicates a decrease in ring-stage parasite sensitivity, is the primary sign of artemisinin resistance (Dondorp et al., 2009). Another significant symptom that could occur before noticeable increases in treatment failure rates is the rise in gametocytaemia rates (Barnes et al., 2008). The spread of antimalarial drug resistance is significantly influenced by this. "Treatment failure," or the inability to eradicate malaria parasitemia or alleviate clinical symptoms even when antimalarial medication is taken at the recommended dosages, is not only due to antimalarial drug resistance. Other causes include improper dosage, noncompliance, subpar medication, drug interactions, impaired drug absorption, medication vomiting, odd pharmacokinetics, or misinterpretation of the illness. Because it promotes the development and spread of antimalarial drug resistance and enhances the transmission of malaria, treatment failure poses a risk to both the patient and the community (Conrad & Philip, 2019).

Resistance develops more slowly with combination therapy. The well-known idea that underpins the therapy of HIV infection, leprosy, and tuberculosis also applies to malaria (White et al., 2009; Barnes, 2008). The per-parasite likelihood of developing resistance to both treatments is the product of their per-parasite probabilities when two medications with distinct modes of action and,

consequently, separate resistance mechanisms are administered together. The longer it takes for resistance to arise, the lower the de-novo per-parasite probability of resistance development (WHO, 2018). The optimal pharmacokinetics for an antimalarial medication have been hotly debated. Drugs with this feature must be taken for at least seven days when taken alone, however patients don't often stick to their seven-day regimens. On the other hand, rapid clearance guarantees that the residual concentrations won't selectively filter out resistant parasites. A combination must have at least one ingredient with an elimination half-life longer than 24 hours in order to be effective during a 3-day regimen (Woodrow & White, 2017). Because of their high killing rates (parasite reduction rate, approximately 10000-fold per cycle), lack of side effects, and lack of significant resistance outside of Southeast Asia, artemisinin derivatives are especially effective when used in combination with other antimalarial medications (Nosten et al., 2000).

As long as adherence is good, combinations of rapidly eliminated artemisinin derivatives, such as lumefantrine, mefloquine, and piperaquine, protect completely against the development of resistance to the artemisinin derivatives when taken for three days. However, they do not protect the partner's "tail" that is gradually being cut off (Nosten & White, 2007). Resistance may arise in the parasites that have not yet been destroyed by the artemisinin derivative, but it can occur in any parasite. Of the parasites present in an acute symptomatic infection, only a very tiny percentage (<0.00001%) are exposed to the partner medication alone. Concerns regarding the loss of the only highly effective malaria treatment currently available have been raised by the emergence and spread of Plasmodium falciparum parasites with decreased susceptibility to artemisinin derivatives, as well as by treatment failures following treatment with artemisinin-based combination therapies (ACTs) in the Greater Mekong Subregion (GMS) (Menard & Dondorp, 2017; Woodrow & White, 2017). PfKelch13 mutations in the GMS have been linked to artemisinin

resistance, which is defined as delayed parasite clearance after treatment with traditional ACT regimens. A number of these mutations have been confirmed as molecular indicators of artemisinin resistance in that area (Ariey et al., 2014; Ménard et al., 2016).

Artemisinin resistance may have spread or emerged in Eastern India, where delayed parasite clearance combined with a high rate of parasite survival in the ring survival assay (RSA) and the presence of certain pfKelch13 mutations have been observed. Moreover, some pfKelch13 mutations associated with delayed parasite clearance have been also reported in South America (Chenet et al., 2016; Mathieu et al., 2018). Nevertheless, different pfKelch13 mutations have been observed in Africa, but these were not associated with artemisinin resistance (Taylor et al., 2015; Kamau et al., 2015). Artemisinin derivatives are very effective antimalarials that can quickly reduce parasite biomass, but because of their short half-life, they must be used in combination with partner medications that have longer half-lives to eliminate any parasites that remain after a 3-day course of ACT treatment (Nosten & White, 2007). Indeed, ACT failure is caused by both artemisinin resistance and partner medication failure (Leang et al, 2013; Saunders et al, 2014). The authors' focus on patient ACT resistance and possible approaches to deal with it was stimulated by this background.

Methods

Following ACT treatment, blood samples were examined in a lab for malaria parasites using a descriptive cross-sectional study design. 2,720 respondents at 26 medical facilities in Lagos State, Nigeria, provided facility-based data. Prescriptions were evaluated according to the demographics of the patients, including age, antimalarial drug classes, and classes of drugs prescribed in conjunction with the antimalarial treatment. Prescription evaluations of patients' use of

antimalarial drugs after two (2) weeks, one month, two months, and three months were recorded. Plasmodium falciparum recrudesce was evaluated in order to identify potential resistance and the cause of treatment failure. Version 26 of the Statistical Product Solution Service (SPSS) was used to analyze the data.

In order to detect the presence of P. falciparum, blood samples from 70 participants were collected and tested using rapid diagnostic tests (RDT) and microscopy. These volunteers were treated using the test, treat, and trace treatment technique. After a week of sampling and the administration of an artemisinin-based combination therapy (ACT) given by the resident physician, their blood samples were retested to ensure complete eradication of the parasite. They used a Rapid Diagnostic Test kit. By dyeing thick and thin blood films on a glass slide, malaria parasites could be seen and the disease could be diagnosed under a microscope. The blood spot was stirred in a circular motion using the slide's corner to create a thick blood film. Care was taken to prevent the preparation from becoming too thick, and it was let too dry without the use of fixative. Following drying, the area was stained for 20 minutes with diluted Giemsa, and the film was rinsed for three minutes in buffered water. After letting the slide air dry vertically, it was inspected under a light microscope. After 15 minutes, certain bands appeared on the test card window, indicating that the patient's blood sample had Plasmodium falciparum or one of the other three human malaria species. The observation was checked with the laboratory positive control containing *P. falciparum*. The apparatus used was the Bioline Malaria Ag test kit.

Results

A total of 2,720 prescribed cases of malarial with various antimalarial drugs including Artemisinin-based combination therapy (ACT) were collected out of which 1,397 (51.36%) were females and

1,160 (42.65%) males with prescriptions based on hospital visits from March 2020 to July 2021. The majority 820 (30.45%) were within the age bracket of 21-30 years (Table 1).

Table 1: Patients' demographic characteristics (n = 2,720)

Variables	Observation	Percentage
Gender		
Male	1160	42.65%
Female	1397	51.36%
Age group	**Observation**	
0-10	337	12.39%
11-20	530	19.49%
21-30	820	30.45%
31-40	290	10.66%
41-50	541	19.89%
>50	202	7.43%

Table 2 shows the frequency distribution of the total number of patients with the types of antimalarial prescriptions. The highest value was between the age group 21-30 (30.45%) and the age group above 50 years had the lowest prescription of anti-malarial (7.43%). ACT antimalaria was mostly prescribed based on the WHO guideline for the treatment of uncomplicated *P. falciparum.* The various dosage forms observed were the IM injections, tablet forms and some paediatric suspensions.

Table 2: Prescribed ACT- antimalarial agents (n = 2,720)

Antimalarial drug	Dosage form	Quantity	Percentage
sulfadoxine/pyrimethamine	Tablet	579	21.00%
Artesunate	Tablet	147	5.00%
Artemether+Lumefantrine	Tablet/Syrup	1305	47.33%
I.M Artemether	Injection	172	6.24%
I.M Artesunate	Injection	87	3.16%
Dihydroartemisinin-Piperaquine	Tablet	151	5.48%
Artesunate-Mefloquine	Tablet	26	0.94%
Artesunate-Amodiaquine	Tablet	23	0.83%
Artesunate-Pyronaridine	Tablet	0	0.00%
Artesunate+ SP	Tablet	110	3.99%
Artemether+Lumefantrine+ SP	Tablet	157	5.69%

Antibiotic medication co-prescribed

Co-prescribed antibiotic drug as shown in Table 3 reveals that ciprofloxacin 176 (23.31%) was mostly prescribed, Azithromycin followed with a frequency of 132 (17.48%), with clarithromycin 8 (1.06%) having lowest frequency.

Table 3: List of co-prescribed antibiotics (n = 2,720)

Antibiotics	Quantity	Percentage
Ciprofloxacin tablet	176	23.31%
Cefixime tablet	37	4.90%
Azithromycin Tablet	132	17.48%
Amoxicillin-clavulanic acid tablet	113	14.97%
Amoxicillin Capsule	81	10.73%
Doxycyclin Capsule	10	1.32%
Ofloxacin Tablet	14	1.85%
Metronidazole Tablet	33	4.37%
Cefuroxime Tablet	90	11.92%
Levofloxacin Tablet	31	4.11%
Ceftriaxone Injection	30	3.97%
Clarithromycin Tablet	8	1.06%

Sample Collection for *P. falciparum* Detection

Using the World Health Organization tested, treatment and treatment approach pattern, a total of 70 volunteers was sampled to determine the presence of *Plasmodium falciparum*. Informed consent was obtained from these volunteers (men and women) excluding pregnant women. The demography including contacts was taken for easy tracing. After seven days of being tested and having a complete three-day dose of artemisinin-based combination therapy, they were retested to assess parasite clearance or presence as represented in Table 4.

Table 4: Age of participants with presence of malaria parasite before and after drug administration (n = 70)

Age group	No of volunteers	No of volunteers with parasite	After 7 days of treatment
10-19	15 (21.43%)	15 (21.43%)	15 (21.43%)

20-29	30 (42.86%)	23 (32.86%)	15 (21.43%)
30-39	17 (24.29%)	12 (17.14%)	5 (7.14%)
40-49	5 (7.14%)	4 (5.71%)	4 (5.71%)
>50	3 (4.29%)	1 (1.43%)	1 (1.43%)

Of all 70 volunteers, 55 tested positive for malaria using RDT and microscopy method, while 15 samples showed negative but with clinical symptoms and complaints associated with malaria. The 55 volunteers were given various ACT antimalarial drugs by the prescriber, as this research is not particular about the choice or brand of ACT antimalarial (Table 5). To the other 15 volunteers, the prescribers added an antibiotic to their ACT prescription (amoxicillin/clavulanic acid, cefuroxime, metronidazole, and azithromycin). After 7 days of administration of ACT on the positive tested group of volunteers, samples collected were subjected again to RDT. Forty-two (42) came out negative with no clinical symptoms while 13 had a positive test. There had been poor adherence and low compliance among the 13 groups which had caused a relapse as they stopped treatment after 2 doses with claims to have felt better, or having a busy schedule which caused their poor compliance.

Table 5: The types of ACT antimalarial prescription to the volunteers (n = 55)

ACT antimalarial prescribed	No of observation
Artemether/Lumefantrine	37 (67.27%)
Dihydroartemisinin/piperaquine	6 (10.91%)
Artemether injection	10 (18.18%)
Artesunate injection	4 (7.27%)
Artesunate/SP	3 (5.45%)

Discussion

According to the study's findings, the age group of 21 to 30 years old accounted for the bulk of cases and had the highest number of prescriptions (30.45%). This implies that individuals in this age group are more susceptible to malaria due to their outdoor lifestyle and activities. This result

is consistent with the WHO (2018) research that identified the population most at risk for malaria episodes. Sulphadoxine pyrimethamine (21.00%) was one of the prescribed antimalarial medications in addition to the Artemisinin-based combination therapy. It was typically prescribed as part of prenatal care and as a prophylactic measure. It was often noted that 1305 (47.33%) patients received the most prescriptions for artemether-lumefantrine. This result is comparable to that of Maiga et al. (2021), who found that the most commonly prescribed treatment for malaria followed a similar routine. Brands like Coartem, Lonart, and Amatem forte pills were frequently recommended. This may explain its widespread acceptance, accessibility, and lower incidence of adverse patient reactions. I.M. Artemether and I.M. Artesunate were utilized at 6.24% and 3.16%, respectively, whereas Artesunate was employed as monotherapy and was seen to have a 5.00% efficacy. Dihydroartemisinin-piperaquine was used in 5.48% of cases. Rarely were combinations of artesunate and mefloquine and artesunate and amodiaquine administered, with respective rates of 0.94% and 0.83%. No prescription for artesunate-pyronaridine was found. Its non-availability is the cause of this. Similar results were reported by Maiga et al. (2021) to bolster this conclusion.

Complete parasite clearance required the use of antibiotics co-prescribed with the various ACT-antimalarials, with azithromycin and ciprofloxacin being the most commonly prescribed at 17.48% and 23.31%, respectively. Ayogu et al. (2015) opined that ciprofloxacin is a commonly prescribed antibiotic because it has been shown to enhance the antimalarial activities of artesunate, artemether-lumefantrine, and artesunate-amodiaquine; a combination of ciprofloxacin with these antimalarials may be helpful in the management of Plasmodium falciparum infection or co-infection with salmonellosis. Combining it with CQ also revealed promising efficacy in vitro, prompting a small clinical research with positive first findings (Dunne et al., 2005). Ninety-five

percent of respondents have seen patients return for treatment, 21 respondents have received reports of recurrence following ACT use, and 9.5% do not receive reports of relapse. The findings of Balikagala et al. (2021) are consistent with this one. 15% suggest additional ACT, 5% propose antibiotics in addition to ACT as a potential strategy to tackle resistance, and the majority of prescribers (55%) recommend other antimalarial medications in the event of recrudescence. This finding is not incorrect because it was the same as that of Mathieu et al. (2018), who found a similar thing in their research. Six percent think that the drug must have been of low quality when the patient was exposed to a parasite again, and roughly 12% think that the patient's poor treatment compliance is the cause of recrudescence.

Conclusions

The study highlights that resistance to Artemisinin-based Combination Therapies (ACTs) can develop due to treatment non-compliance, quality issues with ACT medications, and re-exposure to parasites, regardless of the specific ACT administered. These findings underscore the critical need for a multi-pronged approach to combating resistance. Patients must be educated and motivated to complete their prescribed treatment regimens, ensuring the full therapeutic potential of ACTs is realized. Healthcare providers should consistently verify the efficacy and quality of ACTs before prescribing them, addressing potential quality concerns proactively. Additionally, non-pharmaceutical strategies to prevent parasite re-exposure such as the use of insecticide-treated nets, environmental sanitation, and public health awareness campaigns should be vigorously promoted to reduce the risk of reinfection. By implementing these measures, stakeholders can work collectively to preserve the effectiveness of ACTs and sustain progress in the fight against malaria.

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Author's contributions

Etim JJ did the data analysis; Efejene IO conceptualized the study and initial draft; Ibu JM did the corrections and reviews; Ekpo EI was involved in the reviews; Otali CC was involved in the supervision of the research; Etim-John, OJ was involved in data curation; Agbiji NN took part in proof reading the manuscript; Idem IE was involved in the methodology.

Conflict of interest declaration

The authors declare that there is no conflict of interest.

Ethical consideration declaration

Administrative and ethical approval was sought and obtained from the college of medicine of the university of Lagos health research ethics committee with reference number; CMUL/HREC/0918/19. A verbal informed consent was also sought from participant during data collection.

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Authors Biographies

ETIM J. J (PhD-c); University of Calabar

Etim John John is a distinguished lecturer and researcher at the Department of Public Health (Health Services Management and Health Policy Unit) at the University of Calabar, Cross River State, Nigeria. He is the founder and CEO of Joet's Humanitarian Services. He has lectured at Novena University for four years where he was appointed examination officer, served as a member of the examination monitoring and quality assurance team, developed the Core Curriculum Minimum Academic Standard (CCMAS) for the Nigerian University Commission (NUC) where he developed the 30% additional Public Health courses, Secretary to accreditation preparation team/committee, and reviewer of the students' handbook for the public health undergraduate programme. Etim John is a charismatic, dedicated and conscientious public health professional with research, statistics, Human Resources for Health (HRH), health services management, health policies and mental health knowledge and experience. A graduate with a Bachelor of Public Health (BPH), Master of Public Health (MPH) with specialization in health services management, and Doctor of Philosophy (Ph.D.) in Public Health (in-view) from the University of Calabar. He also has experience designing public health interventions, systematic reviews and meta-analyses, data collection, analysis and interpretation with proficiency in Microsoft and Statistical Package for Social Sciences (SPSS), Epi-Info, RevMan-5, and R-stat. He has consulted for some NGOs including Sydani Groups (Sydani Institute for Research and Innovations SIRI), Achieving Health Nigeria Initiative -AHNi, Initiative for People's Good Health, etc. Etim is focused, diligent and task-oriented. He intends to contribute immensely to community development, teaching, research and public health programmes. His philosophy is to make research meaningful through effective and efficient use of data from source to coding, analysis, interpretation, reporting and publication in reputable peer-reviewed journals.

EFEJENE I. O; Delta State University, Abraka

Efegene, Ofejiro Israel holds a bachelor's degree in Pharmacology from Delta State University, Abraka with a research on the effect of herbicide garri on haematological parameters and a master's degree from the University of Lagos, with a thesis on the evaluation of antibiotics and analysis of ciprofloxacin and gentamycin residue in fish sample. He is presently undergoing his doctoral program in pharmacology at the DELSU joint Canada-Israel Neuroscience and Biopsychiatric Laboratory, Department of Pharmacology with a keen interest in the impacts of drugs on prenatal depression. He presently teaches, researches and supervises pharmacology to several students at the College of Medical and Health Sciences of Novena University, He has served as a course adviser, departmental examination officer, and CCMAS 30% course committee member. He has attended several scientific conferences in which his abstract has been published in several books of abstract. He has published several research articles in both local and international reputable journals. He is keen to grow his research interest in neuroscience, antimicrobials and public health with also basic skills in the analysis and interpretation of data.

IBU J. M; Miva Open University, Abuja

Dr. Josephine is the Head of the Department of Nursing Science at Miva Open University, Abuja, Nigeria. She is a leader in healthcare education with a passion for improving lives that has been evident throughout her impressive career. She is a Fellow of the West African College of Nursing, a registered nurse, and a midwife. Dr. Josephine has a Ph.D., Master's, and Bachelor of Science in Nursing Education, demonstrating her commitment to knowledge. Her experience is as diverse as her qualifications. She has served as a preceptor at the National Open University of Nigeria, guiding registered nurses in utilizing hospital protocols and bridging the gap between theory and practice. She has also worked with the military and corporate organiztions, managing employee wellness programmes. Her passion for enhancing healthcare in underprivileged communities is fueled by her desire to stop mother-to-child HIV transmission. This passion extends to her research interests which focus on the contributions community health workers can make to strengthening preventive and rehabilitative care.

EKPO E. I; College of Health Technology Calabar

Ekpo, Ekpo Iyamba is a Lecturer at the College of Health Technology Calabar, Cross State. He holds a National Diploma in Medical Image Processing/x-ray Technician from the College of Health Technology, Calabar, a Bachelor of Science degree from Ebonyi State University and a Master's degree in-view from the same university with specialty in medical biochemistry. Mr Iyamba worked with General Hospital Ugep in Yakurr Local Government Area before transferring his services to the College of Technology Calabar. In the college, he has been a seasoned lecturer involved in teaching and mentoring students. He has served as a member of the college examinations committee, treasurer Academic Staff Union of Polytechnics (ASUP) College of Health Technology Calabar Chapter, Board member representing Congress in the academic board

of the college and presently examination officer in the department of radiography and a deputy director in the consultancy services unit.

OTALI C. C; Novena University Ogume

Cyril is a lecturer in the Department of Biological Sciences, Novena University Ogume, Delta State, Nigeria. He has BSc, masters and PhD degrees in his field of expertise. He has mentored different students and published different manuscripts in both local and international peer-reviewed journals. He has attended different professional conferences where he presented mind-blowing papers and abstracts.

ETIM-JOHN, Obasesam John (MPH-c); University of Calabar Teaching Hospital

Obasesam is a distinguished radiographer and a researcher in the Department of Radiology, at the University of Calabar Teaching Hospital. She holds a Bachelor of Science (B.Sc.) degree in Radiography and Radiological Sciences from the University of Calabar and currently undergoing a Master's programme in Epidemiology. She has professional post-graduate training with certifications in Obstetrics and gynecology ultrasonography from the Nigerian Institute of Radiographers, improving breast and gynecological cancer management and outcomes from the International Center for the Study of Breast Cancer Subtypes (ICSBCS) and Morehouse School of Medicine Atlanta, Georgia. She is a licensed radiographer and a member of the Radiographers Registration Board of Nigeria. She has published in high-impact journals and has a passion for improving radiographic and radiological practice in line with public health practice as an epidemiologist (Public Health Radiographer). She is diligent and dedicated to improving the lives of patients and students as a Public Health Radiographer.

AGBIJI N. N; University of Calabar

Nneka is a distinguished lecturer and a passionate researcher at the Department of Public Health, University of Calabar in Cross River State, Nigeria. She holds a Bachelor of Science in Microbiology and a master's in Public Health and Microbiology both from the prestigious Abia State University Uturu, Abia State, Nigeria. Nneka is currently PhD in Public Health and Environmental Microbiology student. She has been trained and has attended so many conferences. She is an expert in environmental health. Worked with Cross River University and taught so many courses including being the seminar/project coordinator of the Department of Microbiology. Written books on environmental impacts and supervised students. She is a researcher and a consultant to some NGOs including A-STEF, GAP and many others. She believed that education is the door to freedom. Nneka won the award of the outstanding lecturer in the Department of Microbiology, University of Cross River, Calabar.

IDEM I. E; University of Calabar

Dr. Iboro Idem is academically credentialed with a Doctor of Philosophy (Ph.D.) in Pharmacology and Toxicology, awarded by the University of Uyo, Nigeria. Her expertise stretches nearly two decades across primary, secondary, and tertiary levels of education. Her comprehensive experience encompasses a wide array of domains, including but not limited to teaching, academic writing, strategic programme planning, staff recruitment process, capacity enhancement initiatives, career counseling and guidance, technical education methodologies, and the development of curricula. Dr. Idem has served as the Rector of Uyo City Polytechnic, Uyo, Nigeria, a position that underscores her remarkable leadership and administrative skills. She also held the position of Head of the Department of Science and Laboratory Technology at Heritage Polytechnic in Eket, Nigeria. She is a director at Ultra Tomorrow Educational Consult, Uyo, Nigeria. She is presently a senior lecturer in the Department of Pharmacology and Toxicology, Faculty of Pharmacy, University of Calabar, Nigeria.