Assessment of Fluid Intake Pattern in Anambra State, Southeast Nigeria

C. C. Ibeh, N. Jisike-Onuigbo, F. O. Emelumadu, C. Ifeadike, M. J. Umeh, C. E. Onah,
A. Mbanuzuru, D. Obi, C. N. Ogbuagu

Abstract — Background: Water is essential for life and accounts for about 70 percent of the human body fat-free mass. Daily loss of 2.5 L in temperate climate occurs on least minimal activity while exercises, rises in temperature, illnesses raise the fluid loss. Adequate intake of water is necessary for optimal body functions, development and health. Estimates of water intake shows wide variations depending on factors such as temperature, activity level, availability and accessibility of fluid, fluid type, packaging, and socio-cultural factors.

Context and purpose of study: Residents in the tropics are exposed to high temperatures and loss of excess fluid from perspiration and would expectedly require high fluid intake for normal body function. A cross sectional study was conducted in Anambra State, southeast Nigeria to assess the fluid intake of subjects. Two hundred and fifty people were selected by multi-stage sampling technique. They were drawn from employees in government secretariats, banks and artisans engaged in motor mechanic worksites. Using a semi-structured questionnaire, calibrated plastic cups, weighing scale and standimeter, the socio-demographic data, the 24-hour fluid intake, weight and height of the subjects were obtained.

Results: The mean age of the respondents was 36.6 ± 11.5 years. 60.1% (146) were males while 39.9% (97) were females. There were 130 (53.5%) civil servants and 113 (46.5%) artisans. The median 24-hour fluid intake was 3.5 L with artisans having higher intake than the civil servants. ($\chi^2 = 16.57$, $df=2$, $p<0.05$). The median fluid intake for males was 3.8 L compared with 3.1 L for females.

Main findings: Less than one quarter of the subjects met the respective WHO recommendations for males and females. About half (47.9%) of the males and 39.2% of the females failed to meet the USA IOM recommendations.

Conclusions: The subjects drank less fluid than people in temperate climes and below international recommendations for moderate activities and for manual labour in high temperatures.

Brief summary and potential implications: Inadequate intake of fluid lead to reduced work/exercise performance, endanger

health resulting in impaired cognition, kidney diseases, cardiovascular disorders and dysfunction in blood sugar regulation.

Index Terms — fluid intake; water-intake; high temperatures.

I. BACKGROUND

Water is essential for life [1] and a major constituent of the human body accounting for about 70 to 75 percent fat-free mass [2]. A person on daily basis loses about 700 ml from insensible water loss, 1.6 L through bodily waste and 200ml in perspiration with normal, non- athletic activity. This means that just living and breathing in a temperate climate requires about 2.5 L a day [3]. Exercise and rises in ambient temperature increase perspiration, leading to additional loss of body water. Similarly, illness can also intensify the loose of body water.

Body water is maintained by balancing daily water intake with losses. The metabolic processes in the body produce about 250ml of water while about 750 ml of water is obtained from the food that is eaten. The remaining 1.5 L is supplied from drinks [4], [5]. In order to maintain a balance, humans need to consume the same, or slightly more, fluid daily than is lost through perspiration, breathing, exercise and other functions.

The estimation of water requirement by the body is highly variable and quite complex. This is because a multitude of intra- and inter-individual factors like differences in metabolism, availability of water, level of activity, ambient temperature, flavour variety, beverage temperature and packaging, proximity of the beverage to the person etc. [2], [6]–[8]. As a result of the variability in water needs, adopting a uniform level is unacceptable but rather recommendations [2], [9], [10], have been made to be used as guide in the assessment and planning of diets for individuals and for groups.

The World Health Organization (WHO) recommends that under average conditions, a 70 kg adult male would require 2.5 L of water daily, while a 58 kg adult female would require 2.2 L. Manual labour in high temperatures will increase the requirements to 4.5 L of water per day for both men and women. Recommendations for children are to be calculated using 1 L per day for a 10 kg child and 0.75 L per day for a 5 kg child [11]. On the other hand, the United States Institute of Medicine (IOM) recommends 2.7 L/day for adult women and 3.7 L/day for adult men [12], [13]. However, the WHO has also recommended that in setting local standards, local adjustments to the daily water consumption value may be needed in order to accommodate

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Christian C. Ibeh, Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.
(corresponding e-mail: christiancibeh@yahoo.com).
N. Jisike-Onuigbo, Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.
F. O. Emelumadu, Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.
C. Ifeadike, Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.
M. J. Umeh, Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.
C. E. Onah, Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.
A. Mbanuzuru, Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.
D. Obi, Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.
C. N. Ogbuagu, Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria.

differences in water intake levels [14]. This is because daily direct and indirect water intake, water source, lifestyle, nutritional status and climate can significantly differ between countries.

This study assessed the fluid intake pattern in Anambra State and the factors that affect them.

II. METHODS

A. Background of study area

The study was conducted in Nnewi North and Awka South Local Government Areas (LGAs) of Anambra State, South East Nigeria. Awka South LGA is the Capital of Anambra State while Nnewi North LGA is the industrial base of the State. Awka South has a population of 189,654 while Nnewi North has a population of 155,443 according to the National population census of 2006 [15].

The State is located in the tropical rain forest with high temperatures and humidity in most months of the year except for brief period of cold dry winds associated with the hamattan season that occurs during parts of the dry season. The state lies in an undulating topography which is drained by the Omambala River (from which Anambra State derives its name). The predominant ethnic group is Igbo and Christianity is the prominent religion. The occupation of the people are farming, trading, civil service jobs and artisan.

The study was conducted in the hot dry season with high temperature and moderate humidity. The daily temperatures of Awka for January, February and March 2018 varied between 37 °C and 22 °C (January: max 37 °C, average 28 °C, min 22 °C, February max 37 °C, average 30 °C, min 25 °C; March max 35°C, average 29 °C, min 25 °C) while the atmospheric humidity were 32%, 57% and 67% for January, February and March respectively. The cloud cover for Awka were 6%, 30% and 46% for the months of January, February and March respectively [16]. The temperature values of Nnewi for the three months ranged from 22 °C to 36 °C (January: max 36 °C, average 28 °C, min 22 °C, February max 35 °C, average 29 °C, min 24 °C; March max 33 °C, average 28 °C, min 24 °C). the atmospheric humidity were 42%, 64% and 73% for the months of January, February and March 2018 respectively. The cloud cover for Nnewi were 10%, 31% and 44% for the months of January, February and March respectively [17].

B. Study Design

A cross sectional study was carried out in Anambra State to assess the fluid intake of adults and the factors associated with it.

C. Study population

The study population were representatives of the major occupations operating in the state i.e. office workers employed by government and artisans engaged in motor mechanic works. They were drawn from the civil servants working in the State and Local Government secretariats and banks and motor mechanic workers in the two selected towns. The motor mechanics work with minimal equipment (non-mechanized) and operate mostly in open spaces without shades except occasionally under tree shades or the covers provided by the vehicles they are servicing.

C 1. Inclusion criteria

Civil servants engaged in the state/local government or bank workers who are willing to participate in the study. The motor mechanic workers in the two cities who are willing to participate in the study.

C 2. Exclusion criteria

Subjects that met the criteria above but have acute medical conditions at the time of the study or absents from normal physical activities or dietary restrictions e.g. fasting. The study was conducted during the week days to avoid drinking spree and festive activities associated with the weekends.

D. Sample size determination

Required sample size was calculated by using the formula for cross sectional study for estimating a quantitative variable (mean value in this case) [18].

$$n = \frac{Z^2 \cdot SD^2}{d^2},$$

where,

n – estimated sample size;

Z – Standard Normal Variate (at 5% type 1 error ($P \leq 0.05$) is 1.96;

SD – Standard deviation (standard error) of variable, equals 19 (the mean total water intake from all source for US adult population is 3311 ± 19 mL) [13];

d – Absolute error or precision set for the study.

The estimated sample size is:

$$n = \frac{1.96^2 \cdot 19^2}{2.5^2} = 222$$

This is approximated to 250 subjects.

E. Sampling technique

A multi-stage sampling technique was used for the selection of the subjects. The first phase of the sampling was the selection of two towns from two of the three senatorial districts of Anambra State; Awka South for Anambra Central Senatorial District and Nnewi North from Anambra South Senatorial District. In each of the two selected towns, a cluster sampling technique was used to select groups of workers – artisans and civil servants.

The clusters selected for the civil servants in Nnewi were Local Government secretariat and two banks while the clusters selected for Awka South LGA were ministries in the State secretariat. For the manual workers' group, three motor mechanic settlements were selected in Nnewi and three in Awka. In each selected clusters, subjects were recruited till the required number of people were obtained.

F. Study instruments

The study instruments comprise of the following:

1. Questionnaires (quantitative) to collect socio-demographic data of subjects and fluid intake diary.

2. Anthropometric measuring instruments – weighing scale for weight measurement, stadiometer for height.

Calibrated plastic cups for assessment of 24-hour fluid intake.

F 1. Pretesting

The research instrument was pretested among civil

servants and the (artisans) motor mechanics in Anaocha LGA and Dunukofia LGA in Anambra State. The findings were used to refine the research instrument and procedures.

G. Data Collection Methods

Questionnaires were administered to the subjects and relevant data obtained from them; socio-demographic data, age, sex, education, marital status, occupation, etc. Weight and height measurements were conducted by trained assistants (medical doctors undergoing specialist training in public health) with necessary measures for reliability and standardization of records taken in order to reduce bias.

Subjects were tutored on how to assess the quantities of water and other liquids they drank and were issued calibrated plastic cups. They were taught on how to measure and estimate their fluid intake and record same for a 24-hour period. This was conducted by a seasoned Nutritionist to ensure proper measurements/assessments and documentation. The subjects thereafter provided information on their fluid intake in the last 24 hours (Total Fluid Intake Recall – Pre-survey Day data on fluid intake).

Survey Day 1 data: Quantitative survey on socio-demographic variables, and anthropometric measurement on survey day.

Second Day 2 data: Fluid intake assessed following the issue of cups to subjects – (24-hour Total Fluid Intake Assessed). The subjects provided information on their 24-hour fluid intake using the calibrated plastic cups they were issued. The fluid assessed included – water, fruit/vegetable juice, milk, yoghurt, tea, coffee, alcohol, soft drinks, herbal drinks, energy drinks, pepper soups etc.

The participants in the study were not paid but they were given the opportunity to have their physiological parameters measured (blood pressure, body weight and height and were also provided general health education on wellbeing, diet, exercise and utilization of health care services.

H. Data Management

Data analysis was done using IBM Statistical Package for the Social Sciences (SPSS) software version 21. Descriptive statistical data (percentages, mean, median, standard deviations) were obtained for the independent and outcome variables for the study population.

Comparisons of the fluid intake of the subjects were made with values of WHO and USA IOM recommendations for 70 kg adult males, 58 kg adult females, people on moderate activities and manual labour under high temperatures.

I. Ethical considerations

Ethical clearance was sought and obtained from the Nnamdi Azikiwe University Teaching Hospital Ethical Committee (NAUTHEC). A verbal informed consent was obtained from the participants after a detailed explanation of the procedures involved.

All aspects of the data collection process were non-invasive procedures. Confidentiality was assured to the participants and they were informed that they were at liberty to withdraw at any stage of the study without any repercussion associated with the withdrawal.

III. RESULTS

A. Socio-Demographic Variables

The mean age of the respondents was 36.6 ± 11.5 years. 60.1% (146) were males while 39.9% (97) were females.

55.6% (135) of the subjects were married, 42% (102) were single, while the remaining 1.6% (4) were separated, divorced or widowed.

42% (102) of the subjects had tertiary education, 37% (90) had secondary education, 18.9% (46) had primary while 0.4% (1) had no formal education.

There were 130 (53.5%) civil servants and 113 (46.5%) artisans (motor mechanics). The mean Body Mass Index (BMI) of the subjects was 26.42 ± 4.7 kg/m². The median body mass index (BMI) was 25.8 Kg/M2. Only 1.6% (4) of the subjects had BMI of less than 18.5 kg/m², 41.2% had normal BMI (18.5 – 24.9 Kg/M2), 35% were overweight (25–29.9 kg/m²), 17.3% were Obesity class 1 (30–34.9 kg/m²) and 4.9% were Obesity Class 2 (35–39 kg/m²) – Table I.

TABLE I: SOCIO-DEMOGRAPHIC VARIABLES OF SUBJECTS

S/ N	Socio-demographic variables		Descriptive statistics
1	Age (years)		36.6 ± 11.5 s
2	Sex	Males	60.1% (146)
		Females	39.9% (97)
3	Marital status	Married	55.6% (135)
		Single	42% (102)
		Separated, divorced /widowed	1.6% (4)
4	Educational status	No formal Education	0.4% (1)
		Primary	18.9% (46)
		Secondary	37% (90)
		Tertiary	42% (102)
5	occupations	Civil servants (office workers)	53.5% (130)
		Artisans (motor mechanics).	46.5% (113)
6	Body Mass Index (kg/m ²)	Underweight	1.6% (4)
		Normal BMI	41.2%
		Overweight	35%
		Obesity class 1	17.3%
		Obesity class 2	4.9%
		Mean BMI	26.42 ± 4.7
		Median BMI	25.8

Underweight=<18.5, Normal BMI=18.5-24.9, Overweight=25-29.9, Obesity class 1=30-34.9, Obesity class 2=35–39 kg/m².

B. Total Fluid Intake Of Subjects

The mean total fluid intake recall (for 24 hours) for the day before the survey was 3.46 ± 1.7 L and a median of 3.2 L. The mean total fluid intake assessed for 24 hours following the provision of the calibrated cups was 3.78 ± 3.1 L with a median of 3.5 L (Table II). The value obtained on the Day 1 of the survey based on the assessment of the fluid intake measured by the subjects using the calibrated cups is accepted as the most appropriate measure of fluid intake. (*The skewness of the data distribution (fluid*

intake assessed) is 9.967 and kurtosis 130.909). The median value of the total fluid intake assessed is therefore taken as the preferred 24-hour fluid intake of the subjects.

TABLE II: DISTRIBUTION OF TOTAL FLUID INTAKE OF SUBJECTS
ACCORDING TO SEX

S/ N	Fluid Intake (mL)	Frequency and Cumulative Frequency (Cumulative)		
		Male	Female	ALL Subjects
1	300-	1.4%	5.2%	2.9%
	1499	(1.4%)	(5.2%)	(2.9%)
2	1500 -	6.2%	10.3%	7.9%
	1999	(7.6%)	(15.5%)	(10.8%)
3	2000 -	3.5%	6.1%	4.6%
	2199	(11.1%)	(21.6%)	(15.4%)
4	2200 -	6.3%	12.4%	8.7%
	2499	(17.4%)	(34.0%)	(24.1%)
5	2500 -	5.5%	5.2%	5.4%
	2699	(22.9%)	(39.2%)	(29.5%)
6	2700 -	4.2%	6.2%	4.9%
	2999	(27.1%)	(45.4%)	(34.4%)
7	3000 -	11.1%	16.5%	13.3
	3499	(38.2%)	(61.9%)	(47.7%)
8	3500 -	9.7%	6.1%	8.3
	3699	(47.9%)	(68.0%)	(56.0%)
9	3700 -	22.2%	14.5	19.1
	4499	(70.1%)	(82.5%)	(75.1%)
10	4500-	29.9%	17.5%	24.9
	9000	(100%)	(100%)	(100%)

The values in parenthesis are cumulative frequencies.

The ranges used in the fluid intake were taken to capture the various recommendations set by WHO and USA IOM for males and females in normal conditions and in high temperatures.

C. Fluid Intake and socio-demographic variables

There is no statistical association between total fluid intake and age of subjects, ($\chi^2=1.6635$, $df=6$, $p>0.05$), educational status of subjects, ($\chi^2=6.581$, $df=6$, $p>0.05$) and marital status ($\chi^2=0.121$, $df=2$, $p>0.05$). There is statistical association between the occupational status of the subjects and total fluid intake ($\chi^2=16.57$, $df=2$, $p<0.05$) with the artisans having higher proportions of subjects (64.6%) of those who drank 3.5 L and above compared with 39.2% of civil servants who drank 3.5 L and above (Table III).

TABLE III: RELATIONSHIP BETWEEN SOCIO-DEMOGRAPHIC VARIABLES,
BMI AND TOTAL FLUID INTAKE

S/ N	Socio- demographic variable	Statistical test	value	p value	Remark
1	Age	χ^2	1.6635 ($df=6$)	$p>0.05$	No statistical significance
2	Educational status	χ^2	6.581 ($df=6$)	$p>0.05$	No statistical significance
3	Occupational status	χ^2	16.57, ($df=2$)	$p<0.05$	There is statistical significance
4	Marital status	χ^2	0.121, ($df=2$)	$p>0.05$	No statistical significance
5	Sex	Z	4.14147	$P<0.05$	There is statistical significance
6	BMI	χ^2	3.388, ($df=4$)	$p>0.05$	No statistical significance

No statistical association was established between the total fluid intake and the Body Mass Index of the subjects ($\chi^2=3.388$, $df=4$, $p>0.05$).

D. Fluid Intake by sex

The mean total fluid intake for males was 4.2 ± 3.7 L and median is 3.8 L.

About one sixth (17.4%) of the male subjects drank less than the 2.5 L recommended by the WHO for males.

The mean total fluid intake for females was 3.2 ± 1.4 L and median 3.1 L.

About one fifth (21.6%) of the females drank less than the 2.2 L per day recommended for females by the WHO. There is statistical difference between the fluid intakes of males and females ($Z=4.14147$, $p<0.05$).

E. Fluid Intake by sex in moderate activities and high temperatures

Fifty six percent (56%) of the subjects drank less than the 3.7 L of fluid recommended by the WHO for people engaged in moderate activities. On the other hand, 75.1% of the subjects drank less than 4.5 L which is the recommended value for persons engaged in manual labour in high temperatures.

About 48% (47.9%) of males drank less than 3.7 L for moderate activity and 70.1% drank less than 4.5 L for manual labour in high temperatures. On the other hand, 68% of the females drank less than the 3.7 L for moderate activity and 82.5% drank less than 4.5 L for manual labour in high temperatures.

IV. DISCUSSION

Hydration involves a dynamic balance between water intake and loss and is maintained through both behavioral and physiological responses. Water gains come almost entirely from fluids and water in food, as metabolic water accounts for only a small fraction of daily water gain [19]. The study is focused on the total fluid intake by subjects in the form of water, beverages including alcohol, juices etc.

The mean Total Fluid intake obtained a day before the survey (recall) was 3.46 ± 1.7 L and a median of 3.2 L. The mean Total fluid Intake assessed for 24 hours following the provision of the calibrated cups was 3.78 ± 3.1 L with a median of 3.5 L. The total fluid Intake assessed using the calibrated cups is taken as the preferred 24 hour fluid intake of the subjects. Since the data is skewed (skewness 9.967 and kurtosis 130.909), the median in this study is accepted as a preferred measure of central tendency (3.5 L).

The age of the subjects, educational status, marital status were not statistically associated with the total fluid Intake. The ages of the subjects studied were in the active working population mostly between 18 and 60 years with small proportion of people between 60 and 65 years (2.1%). This may explain the non differences in water intake between the ages. However, Adam et al, found association with age, race and social class [18]. Other studies among elderly and institutional subjects have found associations between ages and fluid intakes [20- 22].

The subjects studied consumed less quantities of fluid compared with recognized standards set by the World

Health Organization (WHO) [11] and the United States Institute of Medicine (IOM) [12] as 17.4% of the males drank less than the 2.5 L recommended by the WHO while 21.6% of the females drank less than the 2.2 L recommended for females. High percentages of the males (47.9%) and females (39.2%) failed to meet the 3.7 L/day for adult men and 2.7 mL/day for adult women recommended by the IOM [12].

For American adults 20-50 years 42.7% of men and 40.6% of women failed to meet the IOM adequate intake value for total water (3700 mL for men and 2700 mL for women) [12]-[13]. This is indicative that people tend to generally drink less than recommended fluid levels. However, the study population in the current investigation were made of 46.5% of artisan workers and 53.5% of office workers operating under high temperatures (35 °C and 37 °C) for whom the WHO recommended a daily fluid intake of 4.5 L, yet their fluid intake still lag behind (or for females equate to) that of the Americans who live in temperate climate. A number of factors have been recognized to influence fluid intake such as physiologic responses, sensations, preferences, cultural influences, learned behaviors, fluid characteristics, and environmental factors [23]-[28]. Some of these may account for the observed lower quantities of fluid in this study.

Conventionally, people who work or exercise in high temperatures are encouraged to ingest extra volumes of fluid in order to maintain the body's homeostatic mechanism and avert impaired work/exercise performance or endanger health [29]-[30]. High fluid intake is also encouraged to maintain good performance, cognition, avert health conditions such as kidney stone formation, chronic kidney disease, cardiovascular disorders and sustain blood sugar regulation [31]-[37].

The study showed that substantial proportion of the population drank less quantities of water than people in temperate climate and also below the recommendations of both the WHO and the USA IOM despite operating under high temperatures.

COMPETING INTERESTS

There is no competing interest as the study was not sponsored by any external body and none of the investigators is engaged in any water, beverage or other related business that the study findings may promote their interests.

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Prof. Christian C. Ibeh.

MBBS, UNN 1987, FWACP 1994, Diploma Health System Management Galilee College Israel 2006. Consultant Public Health Physician, NAUTH Nnewi/Academic staff, CHS NAU Awka, Nigeria. Professional Associations – NMA, MDCAN, AHPN, EPISON, IEA.

Dr Jisieike Onuigbo Nonyelum Nnenna.

MBBS 1997, NAU Awka, FMCP 2008, NAUTH. Consultant Physician/Senior Lecturer Nephrology Unit, Internal Medicine, NAUTH Nnewi/ NAU Awka, Membership of Associations – NMA, MDCAN, International Society of Nephrology (ISN), Nigerian Association of Nephrology (NAN).

Prof. Emelumadu Obiageli Fidelia.

MBBS UNN 1981, DTM &H Liverpool, UK 1983, FWACP (2004). Consultant Public Health Physician, NAUTH Nnewi and academic staff CHS NAU Awka, Nigeria. Membership of Associations – NMA, MWAN, MDCAN, AHPN, EPISON, IEA, SPHPN.

Prof. Chigozie Ozoemena Ifeadike.

MBBS NAU 1996, FMCPH 2007. Consultant Public Health Physician, NAUTH Nnewi and academic staff CHS NAU Awka, Nigeria. Membership of Associations – NMA, MWAN, MDCAN, AHPN, EPISON, IEA.

Mary Jane Umeh.

BSc, Nutrition and Dietetics, The University of Texas School of Allied Health Sciences 1983, MSc Clinical Nutrition, Texas Woman’s University, Houston 1986. Registered with American Dietetic Association (ADA) 1985. Former Head of Dept, Dietetics Department, NAUTH Nnewi, Anambra State, Nigeria.

Dr Christian Ejike Onah.

BSc Medical Laboratory Science UNN 2006, MSc Chemical Pathology, NAU Awka, 2011, PhD Chemical Pathology NAU Awka 2018. Principal Medical Laboratory Scientist, NAUTH, Lecturer CHS NAU Awka, Nigeria. Published over 35 peer reviewed papers in international journals. Membership of Associations: Medical Laboratory Science Council of Nigeria, Association of Clinical Chemists of Nigeria.

Dr Ahoma Victor Mbanuzuru.

MBBS UNN 2008, FWACP 2019, FMCPH 2019. MSc Statistics NAU (in-view). Published articles in peer reviewed professional journals. Membership of Associations: IEA, EPSON and AHPN.

Dr Darlington C. Obi

MBBS, MPH, FWACP 2019, Consultant Physician NAUTH Nnewi, Lecturer CHS NAU Awka, Anambra State, Nigeria. Formerly Anambra State Co-ordinator Routine Immunization Lot Quality Assurance Sampling Survey. Published articles both in local and international academic journals. Membership of Associations: NMA, MDCAN, IEA,

EPSON, AHPN/

Dr Chukwuanugo Nkemakonam Ogbuagu

BSc Parasitology/ Entomology 1998 NAU, MBBS 2005 NAU Awka. MSc Public Health Parasitology 2008, NAU Awka, PhD Public Health Parasitology 2016, NAU Awka, Nigeria. Principal Medical Officer NAUTH Nnewi, Nigeria. EDCTP scholarship recipient Lisbon Portugal 2018 on Neglected Diseases of Poverty (NDP) Research. WHO/TDR certified Implementation researcher.