INEQUALITIES IN PROMPT EFFECTIVE ANTIMALARIAL TREATMENT AMONG UNDER-FIVE CHILDREN IN NIGERIA: A SECONDARY DATA ANALYSIS

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A thesis submitted in partial fulfilment for the degree of Master of Science in Public Health

by

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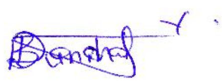
Signature: 

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LIST OF ABBREVIATIONS

ACT	Artemisinin-Combination based Therapy
CSDH	Commission on Social Determinants of Health
DHS	Demographic and Health Survey
DRC	Democratic Republic of Congo
GDP	Gross Domestic Product
GTS	Global Technical Strategy
HEAT	Health Equity Assessment Toolkit
HIV	Human Immunodeficiency Virus
KIT	Royal Tropical Institute
KR	Children Recode
NDHS	Nigeria Demographic Health Survey
NHMIS	National Health Management Information System
NMEP	National Malaria Elimination Programme
NMIS	Nigeria Malaria Indicator Survey
PPMV	Patent and Proprietary Medicine Vendors
RDT	Rapid Diagnostic Kit
RII	Relative Index of Inequality
SSA	sub-Saharan Africa
SII	Slope Index of Inequality
VU	Vrije Universiteit
WHO	World Health Organisation
YLL	Years of Life Lost

DEFINITION OF TERMS

Artemisinin combination-based therapies (ACTs) – These are malaria drugs which contains at least two effective antimalarial drug components with different methods of acting. One of the antimalarial drug in the combination is an artemisinin derivative [1].

Antimalarial monotherapy – "Antimalarial treatment with a single medicine (either a single active compound or a synergistic combination of two compounds with related mechanism of action)" [2]page 9.

Prompt effective antimalarial treatment – Proportion receiving an ACT same or next day, among children under-five years old with fever in the last two weeks who received any antimalarial drugs [3].

Health inequality – This is defined as the differences in health among population subgroups identified using socioeconomic, demographic, and geographic dimensions [4, 5].

Health inequity - This is defined as the unfair and avoidable differences in health among population subgroups identified using socioeconomic, demographic, and geographic dimensions [4, 5].

Equity stratifier – This "refers to a characteristic – such as demographic, social, economic, racial, or geographic descriptor – that can identify population subgroups for the purpose of measuring differences in health and healthcare that may be considered unfair or unjust" [6]page 5.

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# ABSTRACT

Background: Globally, proportion of deaths from malaria is highest in Nigeria and inequity in access to prompt Artemisinin-Combination based Therapies (ACTs) is one cause. Limited research measuring differences in prompt effective antimalarial treatment among subgroups of under-five children in Nigeria exist. Identifying those who are left behind is an important first step to closing the inequality gap in malaria treatment with ACTs.

Objective: To determine the proportion of children who received prompt effective antimalarial treatment, measure the differences and changes in prompt effective antimalarial treatment among subgroups of under-five children in Nigeria and provide recommendation towards closing the inequality gap(s).

Methodology: Using 2013 and 2018 Nigeria Demographic and Health Survey, dataset of 3986 under-five children with fever who took any antimalarial drugs was secondarily analysed. Inequality summary measures were generated. Statistical level of significance was 5%.

Results: About half of the study population were males and females in 2013 and 2018. Only 41.32% received prompt effective antimalarial treatment. Wealth-based (SII = 9.98% points, 95%CI: 3.53 – 16.43; RII =1.27, 95%CI: 1.09 – 1.49) and residence-based (absolute difference = 7.43% points 95%CI: 0.84 – 14.02; relative difference = 1.19, 95%CI: 1.02 – 1.39) inequality in prompt effective antimalarial treatment were most evident. Education-based absolute and relative inequality in prompt effective antimalarial treatment observed in 2013 changed to a state of no inequality in 2018.

Conclusion: Wealth-based and residence-based inequalities in prompt malaria treatment with ACTs exist. Prioritizing these population subgroups for ACT intervention will help reduce the inequality gap and ultimately reduce the malaria burden.

Key words: Inequality, Inequity, ACTs, Malaria, Under-five children

Abstract word count: 250

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CHAPTER ONE: BACKGROUND

1.1 Introduction

The sub-Saharan Africa (SSA) region continues to be disproportionately account for the global burden of malaria [7]. Four countries (Nigeria, Democratic Republic of Congo (DRC), Tanzania, and Mozambique) in the region account for over 50% of the global deaths from malaria with Nigeria alone accounting for about 31.9% of the global deaths [7]. Despite this high burden, malaria cases and its complications can be reduced in these endemic regions using a four-pronged intervention approach [8].

Malaria case management is one of the four-pronged intervention approaches recommended for the reduction of malaria cases and its complications in malaria-endemic regions; the other intervention approaches are prevention, larva control and other vector control interventions, and mass drug administration and mass fever treatment [8]. The case management approach is a malaria program area which is used for the diagnosis and treatment of malaria [9, 10]. The case management approach recommends that persons with malaria be diagnosed and treated early within twenty-four hours of appearance of the first symptom, and that surveillance measures be put in place to track malaria cases and deaths (the test, treat, and track approach) [10-12].

The recommended treatment for uncomplicated malaria, according to the World Health Organization (WHO) and the national guideline for malaria in Nigeria is artemisinin-combination based therapies (ACTs), instead of antimalarial monotherapies [1, 11]. When used as prescribed, ACT is an effective malaria drug which helps to prevent progression of uncomplicated malaria to more severe forms, decrease the circulating malaria parasite in man, and also helping to prevent antimalarial drug resistance. The overall effect of this is the reduction in morbidity and mortality from malaria [11, 12]. Despite the numerous benefits of using ACT in malaria treatment, millions of people in countries with high malaria burden still lack access to it [7].

In order to ensure that all countries are on track towards ensuring a world free of malaria the WHO Global Technical Strategy (GTS) for Malaria 2016-2030 report reiterated the need for all countries to develop strategic goals, milestones, and targets for each malaria program area as well as outcome and impact indicators to help monitor progress towards the milestones [13]. In countries with high malaria burden, including Nigeria, progress monitoring for malaria treatment is done at the population level using a standard outcome indicator which measures the proportion of antimalarial treatment for under-five children which is ACT [2, 3].

In addition to monitoring progress towards malaria targets, monitoring the malaria treatment outcome indicator can also be used to identify who is left behind in terms of access to effective malaria treatment services. This is done by ongoing measurement and analysis of the differences in proportion of uncomplicated malaria treatment that are ACT across social, economic, demographic, and geographic divides in population groups [5, 14].

According to the WHO's Commission on Social Determinants of Health (CSDH) framework, differences in health are rooted in the structural mechanisms which create social hierarchies of class, power, prestige, and discrimination. This social hierarchy assigns individuals in a society to different socioeconomic positions which in turn leads to differential disease exposure and vulnerability, which in turn impacts health and wellbeing [4]. The socioeconomic position of individuals, as well as the economic, cultural and other barriers they face contribute to differential disease consequences by impacting on access to treatment services [4, 15].

Identifying who is left behind through measurements and monitoring therefore is an important first step to closing the inequality gap and gradient in access to effective malaria treatment between those who advantaged and those who are disadvantaged [14]. When this is followed by appropriate actions to tackle the root causes of disadvantage in accessing effective malaria treatment services[4], access to these services by the affected population will improve and this will contribute to malaria morbidity and mortality reduction.

1.2 Background information on Nigeria

1.2.1 Geography, administrative divisions, demography, and economy

Nigeria is a West African country which shares boundaries with Niger in the north, Cameroon and Chad in the east, the Gulf of Guinea of the Atlantic Ocean in the south, and Republic of Benin in the west [16]. The country, which has a total surface area of approximately 923,770 square kilometres, is divided into 36 administrative states and one federal capital territory [16, 17]. The states are grouped into six geopolitical zones namely North-West, North-East, North-Central, South-West, South-East, and South-South Geopolitical zones [16]. The federal capital territory of Nigeria is Abuja [16].

Nigeria is the most populous country in Africa with a projected total population of 216,746,934 in 2022 based on the assumption of an annual growth rate of 2.53% [17]. About 31 million of the Nigerian populace are children under-five years of age [18]. Based on 2019 statistics, approximately equal proportion of the population live in urban and rural areas of the country. [17]

Although the country has about 250 ethnic groups, these are grouped into three main ethnic groups namely Yoruba, Igbo, and Hausa [16]. Like the ethnic groups, although Nigeria is a multi-lingual country, the Lingua Franca is English Language [16]. Christianity and Islam are the predominant religions in the country [16].

Nigeria has the largest economy in Africa with a Gross Domestic Product (GDP) of $432.29 billion as of 2020 [17, 19]. The country is one of the major crude oil exporters in the world and her economy thrives mostly on the petroleum industry. Over the years the rising oil prices at the global level, which has been further aggravated by the Ukrainian war in recent times, has been a challenge to the Nigerian macroeconomy. Due to the high imported gasoline prices back to the country, the revenue that is been generated from crude oil exports by the country is used to subsidise for the high price of imported gasoline. The resultant effects of this, amidst debt repayment and corruption, are constriction of the fiscal space for other sectors (such as health, education, and other infrastructural development) and inflation in the country [16, 20]. In addition to the rise in global gasoline price, the rise in food prices also contributes to the inflation rate in Nigeria [20].

The total unemployment rate and youth (persons aged 15-24 years) unemployment rate in the country has been rising steadily since 2015. As of 2019, the total unemployment rate was 9.8% while the youth unemployment rate was 17.69% [17, 19].

According to the 2020 Nigeria National Bureau of Statistics report, approximately four out of every ten Nigerians live below the country's poverty line of $381.75 per year in 2019 [21]. The current inflation rate are predicted to push more Nigerians into poverty by the end of the year 2022 [20].

1.2.2 Health system

Leadership and governance function in the Nigerian health system is embattled with many challenges, such as lack of political will and commitment, lack of transparency and accountability, ineffective coordination, and corruption [22, 23].

Service delivery within the Nigerian health system is provided formally and informally by public or private actors such as the government, private practitioners, non-governmental organisations, faith-based organisations, traditional birth attendants, traditional healers, traditional bone setters, spiritual healers, and patent and proprietary medicine vendors (PPMV). Ideally, service delivery by accredited providers in Nigeria is expected to be provided based on a three-tier health care system namely primary, secondary, and tertiary levels of care. The primary level of care is expectedly meant to be supported by the secondary and tertiary levels of care through an efficient two-way referral system. This ideal service delivery structure is beset by challenges, such as inequitable distribution of health facilities, poor quality of services, poor attitudes of health workers, and a weak referral system. Patients bypass the primary and secondary levels of care to seek health care at the tertiary level while some bypass the public healthcare facilities to seek health care at the private health facilities [22-24].

Health care financing in Nigeria leaves much to be desired. As of 2019, the general government health expenditure as a percentage of the general government expenditure is just 4%, which is little compared to the Abuja declaration of 15%. In addition, household out-of-pocket expenditure as a percentage of current health expenditure is 71% [25, 26]. Due to, inefficiencies in the risk pooling mechanisms and the purchasing and provider payment mechanisms, the health financing system in Nigeria does not provide Nigerians with access to quality essential healthcare and exposes them to financial hardship [22, 23].

The health information system in Nigeria is faced with a lot of challenges including poor coordination and governance mechanism, poor quality data collection and multiple and parallel data sources with weak data linkages. Currently, the health information system in Nigeria is still disease focused and does not have a policy on how to collaborate with other non-health sector on integrating relevant social determinants of health data for well informed decision making. Also, the system does not have a policy statement on monitoring of health inequality which makes it difficult to determine who is left behind at specific points in time and for evidence-based actions [27, 28].

The human resource for health and access to essential medicines building blocks are also weak and leave much to be desired [22].

1.2.3 Disease burden

Although recent statistics showed that life expectancy for Nigeria improved between 1998 and 2019 and the mortality for all age groups and both sexes reduced between the same time period, the mortality indices for Nigeria compared to other West African country is still poor [29]. Out of 16 West African countries, Nigeria was the sixth country with the highest age-standardised mortality in 2019 [29]. Also, for both boys and girls, Nigeria ranked fourth with respect to under-five mortality in the West African region in 2019 [29].

Malaria was the leading cause of years of life lost (YLL) in the country as of 2019. Other infectious causes of YLL in Nigeria are lower respiratory tract infections, and the Human Immunodeficiency Virus (HIV) [29]. Nigeria, like other developing countries, is confronted with the increasing double burden of disease. Therefore, in addition to the burden of communicable diseases, the burden of non-communicable diseases, such as cardiovascular diseases, is also rising [29].

In 2020, Nigeria led the list of six countries (the other countries are DRC, Uganda, Mozambique, Angola, and Burkina Faso) in the SSA region which accounted for about 55% of the global cases of malaria. Nigeria alone accounted for 26.8% of the global prevalence [7] (see figure 1). In the same year, four countries (Nigeria, DRC, Tanzania, and Mozambique) in the SSA region accounted for over 50% of the deaths from malaria worldwide and Nigeria solely accounted for about 31.9% of the global deaths from malaria [7] (see figure 2). The prevalence of confirmed malaria cases by microscopy among children aged 6 – 59 months with fever in the two weeks preceding the 2018 Nigeria Demographic and Health Survey (NDHS) was 23%, while for the rapid diagnostic test (RDT) it was 36.2% [30].

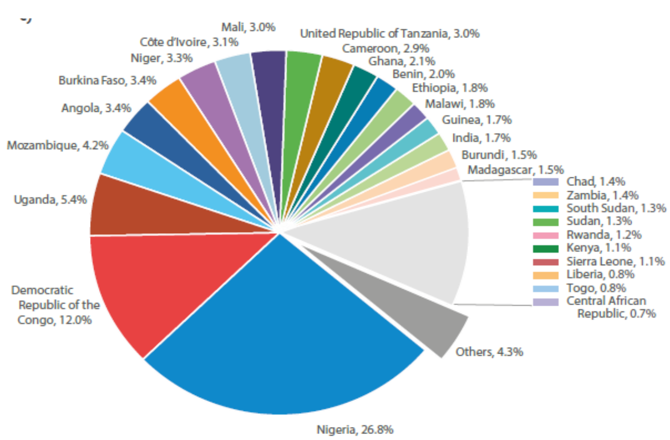

Figure 1: Distribution of malaria cases by country in 2020
Source: World Health Organization [31]

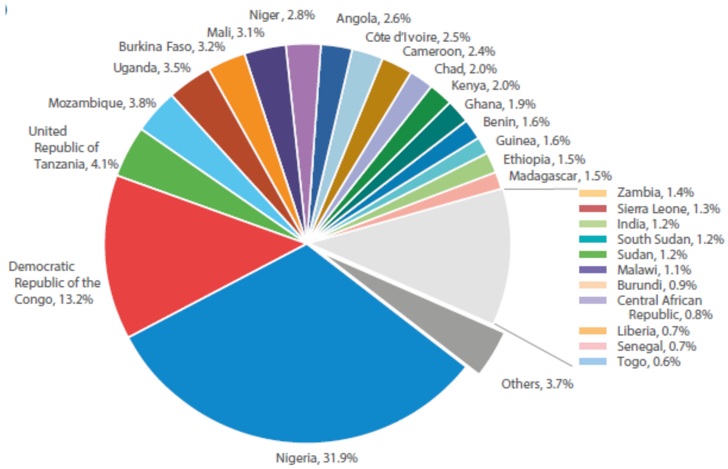

Figure 2: Distribution of malaria deaths by country in 2020
Source: World Health Organization [31]

1.2.4 National Malaria Elimination Programme

The National Malaria Elimination Programme (NMEP) is a program in the malaria unit of the Nigerian Federal Ministry of Health saddled with the responsibility of ensuring that Nigeria is free of malaria [32]. The programme has six malaria program areas namely: integrated vector management; case management; advocacy, communication, and social mobilization; monitoring and evaluation; program management; and procurement and supply chain management [2, 32].

Case management of malaria in Nigeria is based on diagnostic testing with microscopy or malaria RDT and treatment with Artemisinin-combination based therapies (ACTs) for malaria that is not complicated. Other measures include treatment of complicated malaria and chemoprophylaxis [11].

According to the monitoring and evaluation plan of the Nigerian National Malaria Elimination Programme for years 2014 to 2020, the strategic objectives for malaria case management were: "all persons with suspected malaria who seek care in private or public health facilities are tested with RDT or microscopy by 2020 and all persons with confirmed malaria seen in private or public health facilities receive prompt treatment with an effective antimalarial medicine by 2020" [2] page 28. The outcome indicators (malaria diagnostic use in children under age five years with fever and treatment of children under age five years with fever with any antimalarial treatment) used to monitor these strategic objectives among under-five children are derived from population level household surveys such as the Nigeria Malaria Indicator Survey (NMIS) and the NDHS [2]. Ideally, these surveys are expected to be conducted every five years [3]. As of July 2022, six NDHS have been conducted and two NMIS have been conducted. The latest NMIS and NDHS for Nigeria were conducted in 2015 and 2018 respectively [30, 33].

CHAPTER TWO: PROBLEM STATEMENT, JUSTIFICATION, OBJECTIVES

2.1 Problem statement

The burden of malaria in Nigeria continues to be high. In 2020, Nigeria accounted for the highest deaths (31.9%) from malaria globally[7]. One of the many reasons for this high burden is the use of antimalarial monotherapies and substandard drugs for uncomplicated malaria in Nigeria despite the availability of life-saving ACTs [34]. The use of antimalarial monotherapies and substandard drugs for malaria fuels malaria disease progression to severe forms, continued existence of malaria parasite circulation in the community, and emergence of resistance to artemisinin [1, 11, 12].

In order to help curtail the use of monotherapies and substandard drugs for malaria, the NMEP monitoring and evaluation plan 2014 – 2020 document for Nigeria aimed to ensure that everyone confirmed to have malaria has access to prompt and appropriate drugs for malaria [2]. To help realise this plan, the NMEP and her partners made several efforts in scaling up ACT coverage [35]. Despite these efforts and the progress been made, the intervention is still not reaching some people who need it [35].

Health inequality is defined as the differences in health among population subgroups identified using socioeconomic, demographic, and geographic dimensions while health inequity is defined as the unfair and avoidable differences in health among these population subgroups. Health inequality can be measured and monitored, and it can be used as a proxy to assess health inequity [5, 36].

Limited literature which measures and monitor health inequalities in access to effective malaria treatment exist in Nigeria. Research on health inequality measurement and monitoring entails an ongoing data collection and description of the differences and changes in health indicators among population subgroups who occupy different positions within social strata and using such information to make informed decisions [36, 37].

Inequality research is becoming increasingly important as evidence continues to show that health interventions do not reach those who need them the most [38]. Assessments of current the state of inequality and changes over time, using quantifiable measures, helps to understand the pattern and magnitude of a health problem among different population subgroups. This in turn helps with appropriate targeting of interventions to population subgroups that are most in need in the face of limited resources [5]. Till date, only a few studies have attempted to measure the magnitude of inequality in prompt and effective malaria treatment in Nigeria.

Adeyanju and colleagues used the 1990 and 2008 NDHS dataset to conduct a secondary data analysis on the socio-economic inequalities in access to child healthcare among children under five years of age who received treatment from a doctor, nurse, or pharmacist [39]. Their study found that although the magnitude of inequality reduced in 2008 compared to 1990, access to any form of medical treatment for fever or cough was still disproportionately higher among the richer population subgroups compared to the poorer population subgroups. This study was not however specific for inequalities in malaria treatment.

A recent WHO report on the state of inequality in human immunodeficiency virus (HIV), tuberculosis and malaria published in 2021 tried to analyse the inequalities in the diagnosis and treatment of malaria using the following outcome indicators: "prompt care seeking for children aged < 5 years with fever (%), malaria diagnostic use in children < 5 years with fever (%), and prompt treatment of children aged < 5years with fever with antimalarial medicines" [5]page 219 and 220. This WHO report compared the 2018 NDHS data with both the 2008 NDHS and 2010 NMIS data and analysed each of the three malaria case management outcome indicators for inequality across five inequality dimensions (sex, economic status, education, place of residence, and age) [5]. The treatment indicator used in this report does not capture however effective treatment of uncomplicated malaria. To treat uncomplicated malaria effectively, the recommended drug is ACT. [1]

A document on household survey indicators for malaria control published in 2013 recommended an indicator which can be used to measure effective treatment, and which can be generated from household surveys such as the NDHS and NMIS. This indicator measures the "proportion receiving an ACT (or other appropriate treatment according to national policy), among children under-five years old with fever in the last two weeks who received antimalarial drugs" [3]page 43. This indicator is a measure of effective antimalarial treatment [3]. There is dearth of knowledge on literature which has used this indicator to assess inequality in malaria treatment in Nigeria.

The current study therefore tried to fill this study gap by determining the proportion of under-five children with fever who had prompt effective antimalarial treatment, measuring the differences in prompt effective antimalarial treatment among subgroups of under-five children, and changes in the differences between two time periods (2013 and 2018). Given the dataset (2013 and 2018 NDHS) that this study uses only surveys certain demographic and socioeconomic characteristics, measurement of inequality in prompt effective antimalarial treatment was considered across the following inequality dimensions available in the dataset: child's sex, child's age, ethnicity, geopolitical zone, place of residence, household wealth quintile, mother's educational status, and mother's occupational status.

2.2 Justification

Findings from this study will be useful in identifying the differences among population subgroups of children under-five as it relates to prompt effective antimalarial treatment. The study findings will help to better understand how prompt effective antimalarial treatment is distributed in the population, exploring the situation beyond the national average. Identifying these differences will provide information which will be useful for policy makers and health planners to understand where the inequality lies and intentionally prioritize and concentrate malaria treatment interventions on the disadvantaged groups, especially in a lower-middle income country like Nigeria where resources are scarce. The long-term effect of this is the bridging of the inequality gap in prompt effective antimalarial treatment for under-five children in Nigeria. This will in turn help achieve equity in access to quality healthcare delivery for malaria and ultimately an equitable reduction in the morbidity and mortality of malaria among under-five children in Nigeria.

2.3 Research objectives

2.3.1 General objective

To determine the proportion of children with fever who had prompt effective antimalarial treatment, and measure the differences in prompt effective antimalarial treatment among subgroups of under-five children in Nigeria (defined by child's sex, child's age, ethnicity, geopolitical zone, place of residence, household wealth quintile, mother's educational status, and mother's occupational status) in order to provide recommendation for policy formulation and prioritization of intervention strategies.

2.3.2 Specific objectives

1. To determine the proportion of under-five children with fever in Nigeria who had prompt effective antimalarial treatment in 2013 and 2018.
2. To determine the pattern and measure the differences in prompt effective antimalarial treatment among subgroups of under-five children with fever in Nigeria in 2018.
3. To describe the changes in the differences in prompt effective antimalarial treatment among subgroups of under-five children with fever in Nigeria in 2013 and subgroups of under-five children with fever in Nigeria in 2018.
4. To provide recommendations towards closing the inequality gap(s) in prompt effective antimalarial treatment among under-five children in Nigeria.

CHAPTER THREE: METHODS

3.1 Study type

This study is a quantitative secondary data analysis of the 2013 NDHS and 2018 NDHS datasets. The 2018 NDHS dataset was chosen because it is the latest population survey which collected information on malaria outcome indicators in Nigeria and the 2013 NDHS dataset was selected as the comparison dataset to characterise changes in inequality over time.

3.2 Conceptual/Analytical framework

This study used WHO's Commission on Social Determinant of Health (WHO CSDH) conceptual framework as the theory behind how health inequities are produced.

Health inequalities have long been identified to be rooted in social inequalities [4, 15]. This is well illustrated by the WHO Commission on Social Determinant of Health (WHO CSDH) conceptual framework which shows how the complex interplay of socioeconomic and political context, socioeconomic position, and intermediary determinants of health cause health inequity [4]. (See figure 3) Figure 4 complements the WHO CSDH by explaining how differences in health are rooted in the structural mechanisms which create social hierarchy of class, power, prestige, and discrimination. The upstream socioeconomic and political context of a country such as governance and policies create and reinforce social hierarchies of power, prestige, access to resources, and discrimination which leads to social stratification within society and placement of individuals within socioeconomic positions. In this framework income, education, occupation, gender, and ethnicity were used as proxies for the social hierarchies of power, prestige, access to resources, and discrimination. The varying socioeconomic positions shape the experiences of individuals with respect to the intermediary determinants; because of the varying socioeconomic positions, individuals experience differential exposure and vulnerability to health-compromising circumstances which directly lead to inequity in health. Inequity in health in turn feedbacks into the socioeconomic position and socioeconomic and political context through differential social, economic, and health consequences [4].

This study used the socioeconomic positions in the framework as equity stratifiers to identify subgroups of the study population across which differences in prompt effective antimalarial treatment were measured. The equity stratifiers from the framework that were considered for analysis are child's sex, ethnicity, household wealth quintile, mother's educational status, and mother's occupational status. Child's age, geopolitical zone, and place of residence were not shown in the framework, but they were also used as equity stratifiers for this study.

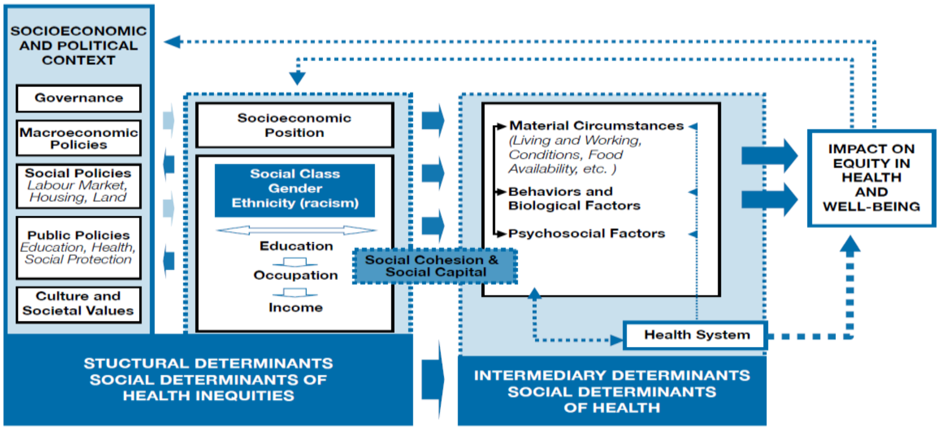

Figure 3: WHO Commission on Social Determinants of Health Conceptual Framework
Source: Solar and Irwin 2010 [4]

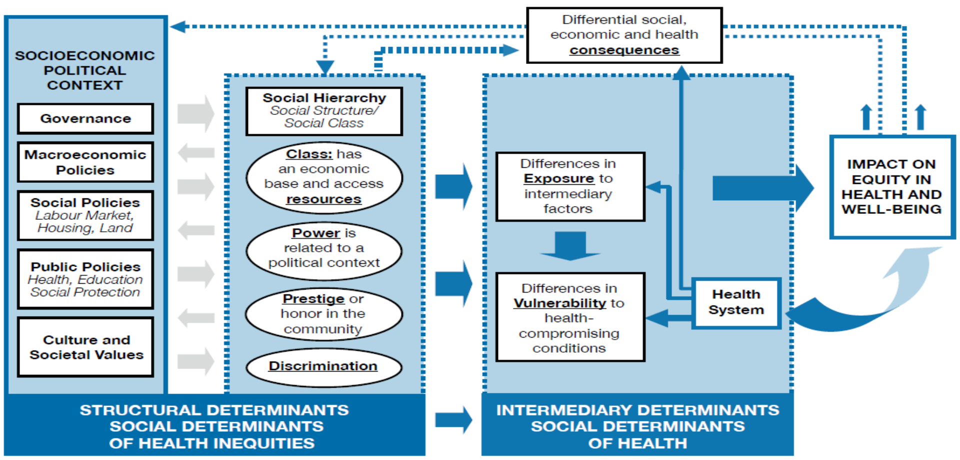

Figure 4: Mechanisms and pathways represented in the WHO Commission on Social Determinants of Health Conceptual Framework
Source: Solar and Irwin 2010 [4]

3.3 Study population

The study population were children under-five years of age. Children under five years were chosen as the study population for this study because: first, they are one of the most vulnerable groups for malaria and second, they cannot access malaria treatment services themselves but rather, they rely on their parents to help them access these services and this further puts them at a disadvantage. As the data used for this study were derived from surveys which depended on how well a mother can recall the responses to the questions asked, this is a potential source of recall bias.

3.3.1 Inclusion criteria

Children under-five years of age who were listed in the 2013 NDHS and 2018 NDHS dataset, who had fever (as reported by their mothers) in the two weeks preceding the data collection for the surveys, and who had received any antimalarial drug (as reported by their mothers).

3.3.2 Exclusion criteria

There were no exclusion criteria.

3.4 Sample

3.4.1 Sample size

Overall, 28596 children were listed in the 2013 NDHS dataset while 30713 were listed in the 2018 NDHS dataset. Of these, only 1215 and 2771 met the study inclusion criteria from the 2013 and 2018 datasets respectively.

3.4.2 Sampling design

This study did not perform any sampling but rather the data of all children listed in the 2013 and 2018 NDHS datasets who met the study inclusion criteria were used.

The 2013 and 2018 NDHS used a stratified sampling technique to select households. All women aged 15 – 49 years in the selected households were eligible for the women survey. And all under-five children of women surveyed were listed and information about vaccination and childhood illness in them were sought from their mothers. A detailed report of the 2013 and 2018 NDHS sampling techniques can be found online at: Nigeria Demographic and Health Survey 2013 and Nigeria Demographic and Health Survey 2018 respectively.

3.5 Data management

Data management was done using Stata version 16.0. The 2013 and 2018 NDHS datasets were downloaded from the MEASURE DHS data-base following approval from the data archivist of the Demographic and Health Surveys (DHS) Program. Datasets of children 0-59 months for both years contained in the children recode (KR) Stata files were used for data analysis. The variables needed for this research were extracted from the two datasets and merged into a new Stata file. A variable for the year the data comes from (2013 or 2018) was generated. The merged Stata dataset was inspected for missing data and outliers. All necessary data cleaning and data recoding were done before data analysis.

One thousand, one hundred and eighty-four (99.59%) observations had missing data for the variable ethnicity in the 2013 NDHS dataset while 627 (22.56%) observations had missing data for the same variable in the 2018 NDHS dataset. This variable was therefore not included in the analysis.

3.6 Data analysis

3.6.1 Study variables

The study variables included in Table 1 were extracted based on the study objectives, analytical framework, and availability of data in the 2013 and 2018 NDHS datasets.

The health outcome indicator used for the inequality analysis was prompt effective antimalarial treatment. It is a favourable indicator which means "it measures a desirable health event that is promoted through public health action" [40]page 3.

Table 1 below is an overview of the variables that were used in this study.

Table 1: Overview of study variables and operational definitions

Variable category	Variable name	Variable description	Operational definition
Health indicator (outcome variable)	Prompt effective antimalarial treatment	Categorical (binary) No (0) Yes (1)	Proportion receiving an ACT same or next day, among children under-five years old with fever in the last two weeks who received any antimalarial drugs Numerator – Number of children under five years old who had a fever in the previous two weeks who received an ACT same or next day following the onset of fever Denominator – Total number of children under five years old who had a fever in the previous two weeks who received any antimalarial drugs [3]
Health inequality dimensions	Child's sex	Categorical (binary) Female (1) Male (2)	Sex of child under-five years of age Male is defined as the advantaged group for this study while female is defined as the disadvantaged group
	Child's age	Categorical (binary) 0-1 (1) 2-5 (2)	Age of child in years as a categorical variable 2-5 years is defined as the advantaged group for this study while 0-1 is defined as the disadvantaged group
	Geopolitical zone	Categorical (binary) Northern (1) Southern (2)	The NDHS dataset had six geopolitical zones: north-west, north-east, north-central, south-west, south-east, south-south. These geopolitical zones were dichotomised into north (all the northern geopolitical zones) and south (all the southern geopolitical zones) for this study Southern geopolitical zone is defined as the advantaged group for this study while northern geopolitical zone is defined as the disadvantaged group
	Place of residence	Categorical (binary) Rural (1) Urban (2)	Where child resides Urban is defined as the advantaged group for this study while rural is defined as the disadvantaged group
	Household wealth index/quintile	Categorical (ordered) Poorest (1) Poorer (2) Middle (3) Richer (4) Richest (5)	The household wealth index/quintile was used as a proxy for household income in this study. This index exists in the NDHS dataset, and it was computed using data of household assets that relates to a household's socioeconomic status. The wealth index was recategorized into five wealth quintiles in the NDHS dataset [30, 41]. Richest is defined as the most advantaged group for this study while the poorest is defined as the most disadvantaged group
	Mother's educational status	Categorical (ordered) No education (1) Primary (2) Secondary (3) More than secondary (4)	Highest educational level attained by child's mother More than secondary is defined as the most advantaged group for this study while no education is defined as the most disadvantaged group
	Mother's occupational status	Categorical (binary) Not currently working (1) Currently working (2)	This refers to whether the child's mother was working at the time of the interview or not working This variable was used as a proxy for mother's occupational status Currently working is defined as the advantaged group for this study while Not currently working is defined as the disadvantaged group
Other variables	Survey year	Categorical (binary) 2013 (1) 2018 (2)	This variable was computed for the purpose of this study Year survey was conducted

3.6.2 Statistical analysis

Statistical analysis was done using Stata version 16.0 and the WHO Health Equity Assessment Toolkit Plus (HEAT Plus) software version 4.0. The WHO Health Equity Assessment Toolkit (HEAT) is a software developed by WHO to analyse health inequality. The HEAT Plus version of the software allows individuals to upload their dataset using either an online version or a desktop version for Windows [42]. The desktop version for Windows was used for this study. It can be downloaded online at: HEAT and HEAT Plus for Windows.

To correct for over sampling and under sampling in the NDHS sampling design, a weighted analysis was done for all analysis in this study by applying survey setting using the weighting factor in the NDHS children recode (KR) dataset. The weights were normalised and applied in the calculation of all statistics.

Occasionally weighted frequencies do not equal the total due to rounding.

Socio-demographic characteristics

To have a general picture of the populations and subpopulations in the two dataset, descriptive statistics for each survey year (2013 and 2018) was performed using Stata. Frequencies and percentages were used to summarise the child's sex, child's age, geopolitical zone, place of residence, household wealth index, mother's educational status, and mother's employment status.

Objective one

To answer objective one which seeks to determine the proportion of under-five children with fever in Nigeria who had prompt effective antimalarial treatment in 2013 and 2018, frequencies and percentages were calculated for the health indicator (see table 1 above for the operational definition of the health indicator) for both years.

Objective two and three

To answer objectives two and three, disaggregation of the health indicator by subgroups of the health inequality dimensions and generation of inequality summary measures for each inequality dimension were done. The disaggregated data and inequality summary measures for 2018 were reported for objective 2 while the inequality summary measures for 2013 and 2018 were compared for objective three.

Disaggregation of the outcome indicator by subgroups of the health inequality dimensions was done using Stata.

The disaggregated data and other requested data were then subsequently inputted into the upload format for HEAT Plus using an Excel template downloaded online at: HEAT Plus template and validation tool. The spreadsheet of uploaded data used for this study is available in Appendix 1.

The data uploaded to HEAT Plus was used to generate absolute and relative summary measures of inequality. The summary measures used for each inequality dimension were based on the number of subgroups for each variable, type of variable, and whether weighting was needed. Table 2 below shows the summary measures used for each inequality dimensions measured in this study. Simple summary measures make use of the extreme values in the subgroup distribution to generate both the absolute and relative measures. HEAT plus calculates the simple absolute measure (difference) by subtracting the value of the health indicator in the most disadvantaged group from the value of the health indicator among the most advantaged group. While the simple relative measure (ratio) is calculated by dividing the value of the health indicator among the most advantaged group by the value of the health indicator among the most disadvantaged group. The complex summary measures make use of the values of all the observations in the subgroup distribution to generate the absolute and relative estimates. HEAT generates the complex summary measures using regression analysis. The simple summary measures are used for all health inequality dimensions but the complex summary measures are used only for inequality dimensions with more than two subcategories [40].

Table 2: Summary measures for inequality analysis

Variable	**Simple measures of inequality**		**Complex measures of inequality**	
	Absolute	Relative	Absolute	Relative
Child's sex	Difference	Ratio		
Child's age (in years)	Difference	Ratio		
Geopolitical zone	Difference	Ratio		
Place of residence	Difference	Ratio		
Household wealth quintile	Difference	Ratio	SII[a]	RII[b]
Mother's educational status	Difference	Ratio	SII[a]	RII[b]
Mother's occupational status	Difference	Ratio		

[a]SII – Slope Index of Inequality; [b]RII – Relative Inequality Index

A value of "0" for the difference (D) indicates that there is no inequality, a positive value indicates a concentration of the health indicator among the advantaged group, and a negative value indicates that the health indicator is concentrated among the disadvantaged group [40].

A value of "1" for the ratio (R) indicates that there is no inequality while the further the value of the ratio is from 1, the greater the inequality. A ratio greater than 1 represents a concentration of the health indicator in the advantaged group and vice versa [40].

A value of "0" for the slope index of inequality (SII) indicates that there is no inequality while values of SII greater than zero indicates inequality and the larger the value, the greater the inequality. A positive value of SII indicates a concentration of the health indicator among the advantaged group, and a negative value indicates that the health indicator is concentrated among the disadvantaged group [40].

A value of "1" for the relative index of inequality (RII) indicates that there is no inequality while the further the value of RII is from 1, the greater the inequality. A value greater than one indicates a concentration of the health indicator among the advantaged group, and a value less than one indicates that the health indicator is concentrated among the disadvantaged group [40].

A confidence interval of 95% was generated for each of the estimates above.

All statistical analysis were done at 5% level of statistical significance.

3.7 Ethical considerations

A full ethical approval or waiver was not obtained for this study because the methodology used does not require either. An approval to use the NDHS datasets was however obtained from the data archivist of the DHS Program. Informed consent was collected from respondents by the DHS data team before the survey was conducted.

The dataset does not contain any personal identifying details. The dataset was not shared with anyone and will not be shared with anyone. All analysis were done on my laptop.

There was no direct benefit to the participants of the 2013 NDHS and 2018 NDHS whose datasets were used, but I do hope that the findings of this study will be useful in formulating policies and prioritizing intervention strategies to help bridge the inequality gap in prompt effective antimalarial treatment for under-five children in Nigeria. This will ultimately help in reducing the morbidity and mortality of malaria among under-five children in Nigeria.

This study caused no harm to the participants of the 2013 NDHS and 2018 NDHS whose datasets were used.

3.8 Dissemination of study results

Findings of this study will be disseminated to KIT (Royal Tropical Institute), Amsterdam, The Netherlands and Vrije Universiteit Amsterdam (VU), Amsterdam, The Netherlands, through a thesis which will be submitted in partial fulfilment of the requirement for the degree of Master of Science in Public Health; to Department of Community Medicine, University of Medical Sciences through seminar presentation; to DHS program through a report; and through publication in a reputable peer-reviewed international journal. Where permitted, the study findings will be disseminated to Nigeria National malaria and control division in the Public Health Department of the Federal Ministry of Health, Abuja, Nigeria through a report; to Ondo State Ministry of Health through seminar presentation; to Ondo State Primary Health Care Development Agency through seminar presentation; and at local and international conferences through presentation.

CHAPTER FOUR: RESULTS

The unweighted sample size was 1215 and 2771 in 2013 and 2018 respectively, while the weighted sample size in was 1189 and 2773 in 2013 and 2018 respectively.

4.1 Socio-demographic characteristics of study population

The socio-demographic characteristics of the study population are shown in Table 3 below. In both 2013 and 2018, about equal proportions of the study population were males and females. The proportion of the study population in 2018 who lived in the northern geopolitical zones was higher (71.63%) compared to 2013 (59.91%). With respect to the household wealth quintile, the highest proportion of respondents was from the upper 40% (richer and richest) of the wealth quintiles in 2013 while the highest proportion in 2018 were from the lower 40% (poorer and poorest) of the wealth quintile. The highest proportion of survey respondents in 2013 were in the middle quintile, while in 2018 this was the second poorest quintile. The same pattern was observed in 2018. Children whose mothers had no education were the highest proportion in both years, however the proportion in 2013 (38.00%) was however lower than the proportion in 2018 (46.28%).

Table 3: Socio-demographic characteristics of the study population

Variable	**2013 N = 1189**		**2018 N = 2773**	
	Frequency	Percentage	Frequency	Percentage
Child's sex				
Female	570	47.91	1356	48.89
Male	619	52.09	1417	51.11
Child's age (in years)				
0-1	576	48.43	1096	39.53
2-5	613	51.57	1677	60.47
Geopolitical zone				
Northern	712	59.91	1986	71.63
Southern	477	40.09	787	28.37
Place of residence				
Rural	685	57.65	1783	64.32
Urban	504	42.35	989	35.68
Household wealth quintile				
Poorest	199	16.74	640	23.08
Poorer	221	18.56	680	24.53
Middle	264	22.23	601	21.67
Richer	255	21.44	493	17.79
Richest	250	21.02	359	12.93
Mother's educational status				
No education	452	38.00	1283	46.28
Primary	227	19.08	439	15.84
Secondary	404	33.94	874	31.51
More than secondary	107	8.99	176	6.36
Mother's occupational status				
Not currently working	353	29.68	798	28.79
Currently working	836	70.32	1975	71.21

4.2 Proportion of under-five children with fever who received prompt effective antimalarial treatment in 2013 and 2018

Figure 5 below provides information about the proportion of the study population who received prompt effective antimalarial treatment. Only about one in ten (12.96%) of the study population in 2013 received ACT same or next day among under-five children who had fever within two weeks of the survey and received any antimalarial drugs. While in 2018, the proportion who received ACT same or next day among under-five children who had fever within two weeks of the survey and received any antimalarial drugs increased to less than half (41.32%) of the study population.

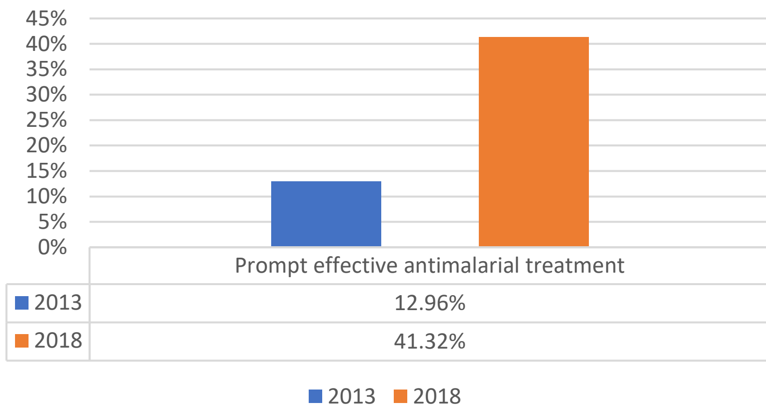

Figure 5: Proportion of under-five children with fever who had prompt effective antimalarial treatment in 2013 and 2018

4.3 Pattern and differences in prompt effective antimalarial treatment in 2018

4.3.1 Pattern of prompt effective antimalarial treatment in 2018

Table 4 below shows the proportion of under-five children who received ACT same or next day in 2018, disaggregated across equity stratifiers.

The overall proportion of under-five children with fever who received ACT the same or next day was 41.32% in 2018 (Figure 5). In 2018, the proportion of under-five children with fever who received ACT the same or next day differed from the overall proportion and varied within population subgroups in this study. More male children (43.17%, 95%CI: 35.642 – 43.261) received prompt effective antimalarial treatment compared to female children (39.39%, 95%CI: 39.438 – 46.986). The proportion of male children who received prompt effective antimalarial treatment was higher than the overall proportion while the proportion for female children was lower than the overall proportion.

When looking across geopolitical zone, more of the advantaged subgroups (southern geopolitical zone) received prompt effective antimalarial treatment compared to the disadvantaged subgroups (northern geopolitical zone). Three hundred and thirty-five (42.61%, 95%CI: 38.370 – 46.965) of the study population who lived in the southern geopolitical zone received prompt effective antimalaria treatment compared to those who lived in the northern geopolitical zone (40.81%, 95%CI: 36.781 – 44.967). The proportion of the advantaged subgroups of under-five children defined by geopolitical zone who received prompt effective antimalarial treatment was higher than the overall proportion while the proportion for the disadvantaged subgroups was lower than the overall proportion.

When receipt of prompt effective antimalarial was disaggregated using place of residence, more of the study population who reside in the urban areas (46.10%, 95%CI: 40.914 – 51.364) received ACT the same or next day compared to those who live in the rural areas (38.67%, 34.751 – 42.748). The proportion of the study population who received ACT same or next day was higher than the overall proportion, while that of those who live in the rural areas was lower than the overall proportion.

Prompt effective antimalarial treatment was highest (51.64%, 95%CI: 43.334 – 59.857) among the richest household wealth quintile when compared to the other household wealth quintiles. This was followed by the poorer household wealth quintile (43.22%, 95%CI: 37.394 – 49.243). Prompt effective antimalarial treatment among poorest and the middle household wealth quintile were both below the national average.

When compared to the other educational subgroups, prompt effective antimalarial treatment was highest (46.68%, 95%CI: 36.523 – 57.122) among the subgroups of the study population whose mother's highest educational status was more than secondary. Prompt effective antimalarial treatment among children whose mother's highest educational attainment was primary was below (32.68%, 95%CI: 27.434 – 38.404) the national average.

Table 4: Disaggregated data of prompt effective antimalarial treatment by inequality dimensions among under-five children with fever who received any antimalarial drugs in Nigeria in 2018

Variable	**Prompt effective antimalarial treatment (2018 overall proportion = 41.32%) Yes (%)**	**95% Confidence interval**
Child's sex		
Female	534 (39.39)	35.642 – 43.261
Male	611 (43.17)	39.438 – 46.986
Child's age (in years)		
0-1	447 (40.75)	36.897 – 44.721
2-5	699 (41.70)	38.057 – 45.426
Geopolitical zone		
Northern	811 (40.81)	36.781 – 44.967
Southern	335 (42.61)	38.370 – 46.965
Place of residence		
Rural	688 (38.67)	34.751 – 42.748
Urban	456 (46.10)	40.914 – 51.364
Household wealth quintile		
Poorest	239 (37.29)	31.932 – 42.980
Poorer	294 (43.22)	37.394 – 49.243
Middle	223 (37.06)	32.195 – 42.205
Richer	205 (41.62)	35.498 – 48.012
Richest	185 (51.64)	43.334 – 59.857
Mother's educational status		
No education	550 (42.83)	38.252 – 47.529
Primary	144 (32.68)	27.434 – 38.404
Secondary	370 (42.37)	37.740 – 47.140
More than secondary	82 (46.68)	36.523 – 57.122
Mother's occupational status		
Not currently working	316 (39.57)	34.834 – 44.504
Currently working	830 (42.03)	38.532 – 45.6112

4.3.2 Differences in prompt effective antimalarial treatment in 2018

Table 5 shows the differences and ratios of the health indicator between the advantaged and disadvantaged subgroups across the equity stratifiers. The result showed that there are inequalities in prompt effective antimalarial treatment between the advantaged (male, 2-5 years, southern, urban, richest, more than secondary, and currently working) and disadvantaged (female, 0-1 year, northern, rural, poorest, no education, and not currently working) subgroups in 2018.

As shown in table 5, the highest absolute inequality and relative inequality in prompt effective antimalarial treatment was found between children from different wealth quintiles. Prompt effective antimalarial treatment had 14.34% points (95%CI: 4.33 – 24.35) absolute difference between the richest and the poorest wealth quintiles and 1.38 (95%CI: 1.11 – 1.72) relative difference between the richest and the poorest quintiles. Prompt effective antimalarial treatment was more concentrated among children from the richest quintile. The absolute and relative differences were statistically significant. (Table 5)

Both the absolute and relative differences in prompt effective antimalarial treatment were also high with place of residence. There was 7.43% points statistically significant (95%CI: 0.84 – 14.02) absolute difference in prompt effective antimalarial treatment between children who reside in urban and rural areas. The relative difference in prompt effective antimalarial treatment between the two subgroups was 1.19 (95%CI: 1.02 – 1.39) and it was also statistically significant. This indicator was more concentrated among the advantaged group of children who reside in the urban areas.

Prompt effective antimalarial treatment was more concentrated among the advantaged subgroup who live in the southern region of Nigeria compared to the disadvantaged group who live in the northern region of the country. The absolute difference and relative difference were not statistically significant (absolute difference = 1.80% points, 95%CI: -4.15 – 7.75; relative difference = 1.04, 95%CI: 0.91 – 1.20).

Inequality in prompt effective antimalarial treatment was lowest when measured using child's age and the health indicator was more concentrated among the advantaged group of children between 2-5 years old. The absolute difference (0.95% points, 95%CI: -4.43 – 6.33) and relative difference (1.02, 95%CI: 0.90 – 1.17) in prompt effective antimalarial treatment defined by child's age were not statistically significant. This is shown in table 5.

Table 5: Simple summary measures for prompt effective antimalarial treatment by inequality dimensions in Nigeria in 2018

Variable	**Prompt effective antimalarial treatment**	
	Difference (95% Confidence Interval)	Ratio (95% Confidence Interval)
Child's sex	3.78% points (-1.58 – 9.14)	1.10 (0.96 – 1.25)
Child's age (in years)	0.95% points (-4.43 – 6.33)	1.02 (0.90 – 1.17)
Geopolitical zone	1.80% point (-4.15 – 7.75)	1.04 (0.91 – 1.20)
Place of residence	7.43% points (0.84 – 14.02)	1.19 (1.02 – 1.39)
Household wealth quintile	14.34% points (4.33 – 24.35)	1.38 (1.11 – 1.72)
Mother's educational status	3.85% points (7.57 – 15.27)	1.09 (0.85 – 1.40)
Mother's occupational status	2.46% points (3.54 – 8.46)	1.06 (0.92 – 1.23)

Table 6 shows SII and RII across household wealth quintile and mother's educational status.

While the magnitude of inequality was reduced compared to the absolute difference and relative ratio, the SII and RII for prompt effective antimalarial treatment persisted and was more concentrated among children from wealthy homes (SII = 9.98% points, 95%CI: 3.53 – 16.43; RII =1.27, 95%CI: 1.09 – 1.49). Both the absolute and relative differences were statistically significant.

Unlike the wealth index, the SII and RII for prompt effective antimalarial treatment was greatly reduced compared to the absolute difference and relative ratio (SII = -0.07% points, 95%CI: -6.89 – 6.76; RII =1.00, 95%CI: 0.85 – 1.18).

Table 6: Complex summary measures for prompt effective antimalarial treatment by household wealth quintile and mother's educational status in Nigeria in 2018

Variable	**Prompt effective antimalarial treatment**	
	SII (95% Confidence Interval)	RII (95% Confidence Interval)
Household wealth quintile	9.98% points (3.53 – 16.43)	1.27 (1.09 – 1.49)
Mother's educational status	-0.07% points (-6.89 – 6.76)	1.00 (0.85 – 1.18)

4.4 Changes in the differences in prompt effective antimalarial treatment between 2013 and 2018

As shown in Figure 6 below, although there was an increase in prompt effective antimalaria treatment coverage between 2013 and 2018 in both males and females (from 13.58% to 43.17% for males and from 12.28% to 39.39% for females), the absolute gap in prompt effective antimalarial treatment between sexes also increased from 1.30% points (13.58% - 12.28%) in 2013 to 3.78% points (43.17% -39.39%) in 2018. The relative inequality remained the same for both years: 1.11 (13.58/12.28) in 2013 and 1.10 (43.17/39.39) in 2018.

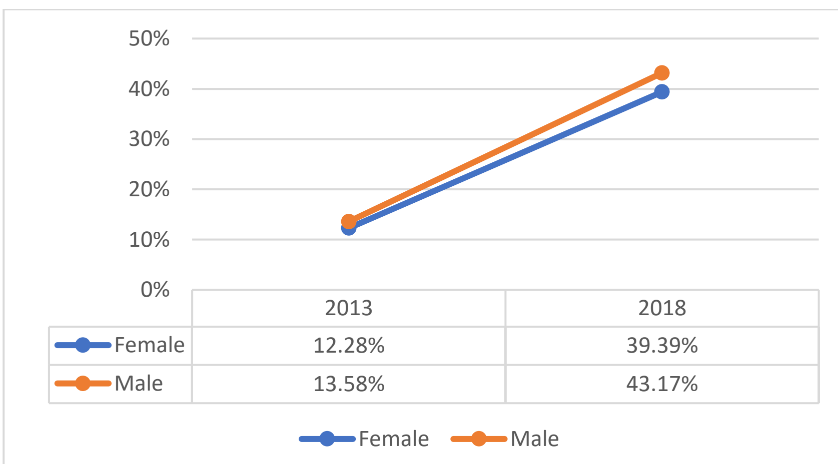

Figure 6: Change in sex-based absolute inequality in prompt effective antimalarial treatment between 2013 and 2018

Figure 7 below shows that there was a slight change in the age-based absolute and relative difference in prompt effective antimalarial treatment between 2013 and 2018. The absolute difference dropped slightly from -1.00% points in 2013 to 0.95% points in 2018 and the relative difference decreased slightly from 0.93 in to 1.02 in 2018. The concentration of prompt effective antimalaria treatment which was more among the disadvantaged group (0-1years) in 2013 however shifted to the advantaged group (2-5years) in 2018.

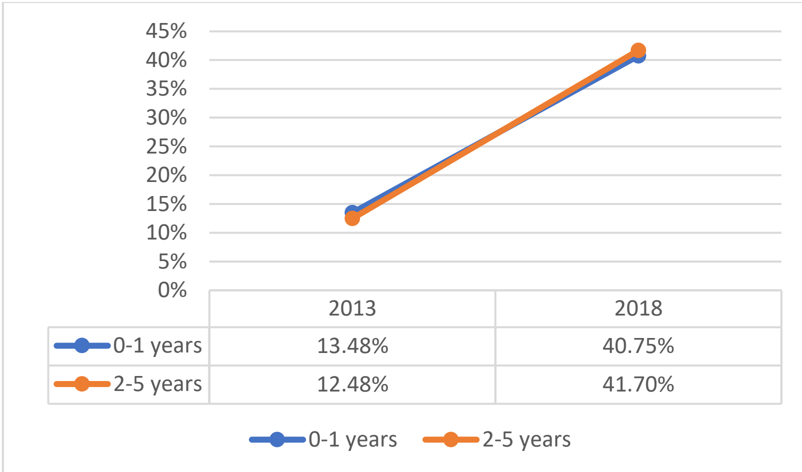

Figure 7: Change in age-based absolute inequality in prompt effective antimalarial treatment between 2013 and 2018

As shown in Figure 8 below, there was a slight increase in the absolute difference in prompt effective antimalarial treatment from 1.75% points in 2013 to 1.80% points in 2018 across geopolitical zones. The relative inequality however decreased from 1.14 in 2013 to 1.04 in 2018. Prompt effective antimalarial treatment was more concentrated among the advantaged group (southern region) in both years.

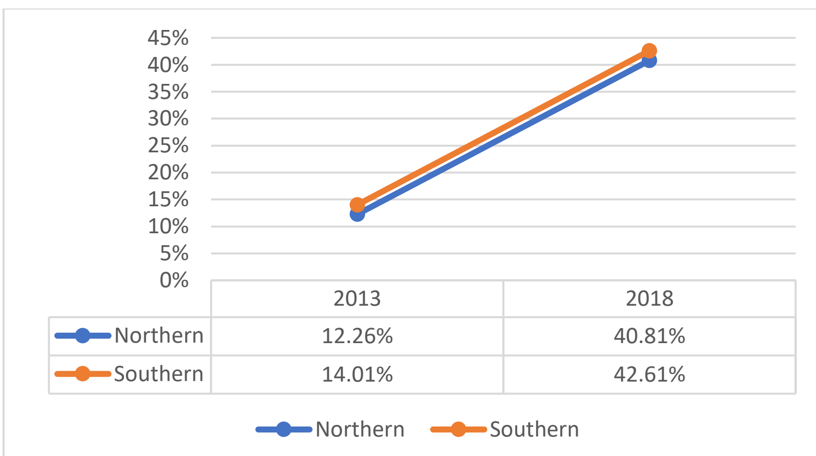

Figure 8: Change in region-based absolute inequality in prompt effective antimalarial treatment between 2013 and 2018

Figure 9 below shows that the residence-based absolute gap in prompt effective antimalarial treatment increased from 3.23% points in 2013 to 7.43% points in 2018. The proportional difference however decreased from 1.28 in 2013 to 1.19 in 2018. Prompt effective antimalarial treatment was concentrated in the urban area in both years.

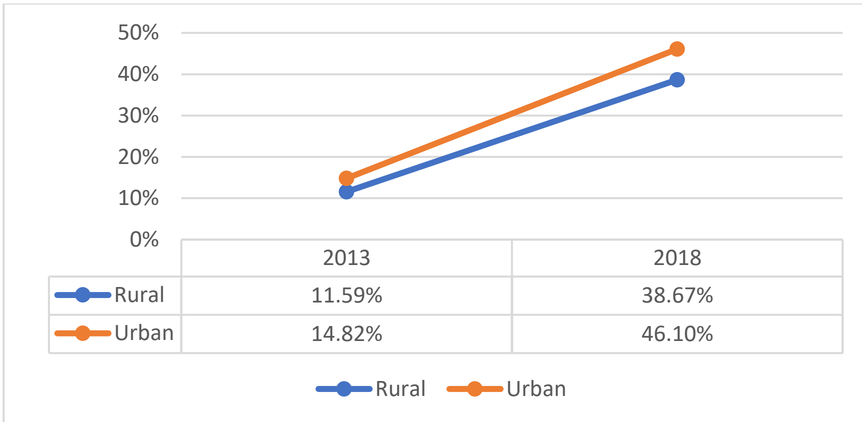

Figure 9: Change in residence-based absolute inequality in prompt effective antimalarial treatment between 2013 and 2018

Figure 10 shows the change in wealth-based inequality in prompt effective antimalarial treatment between 2013 and 2018. The absolute difference in prompt effective antimalarial treatment decreased slightly from 10.00% points in 2013 to 9.98% points in 2018. The relative difference also decreased from 2.18 to 1.27. The concentration of the health indicator was more among the richest household.

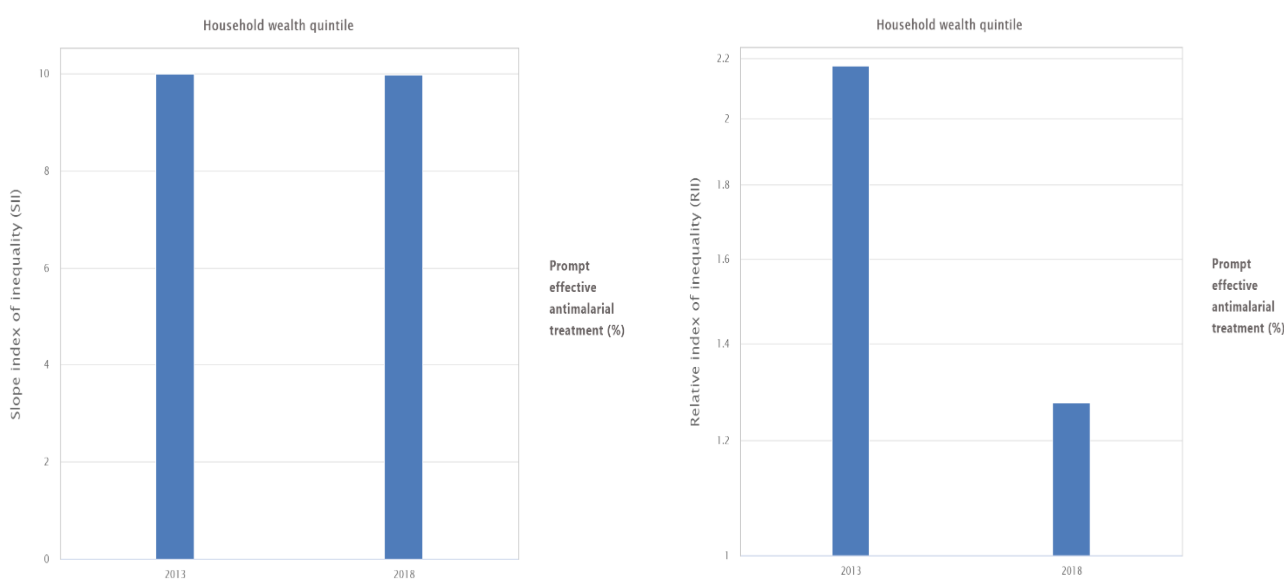

Figure 10: Change in wealth-based absolute (left) and relative (right) inequality in prompt effective antimalarial treatment between 2013 and 2018

Figure 11 also shows that both absolute and relative inequalities in prompt effective antimalarial treatment for children with different mother's educational status reduced drastically from 2013 to 2018. The absolute inequality reduced from 11.64% points in 2013 to almost a non-existent state of no inequality (-0.07%) in 2018. The relative inequality reduced from 2.41 to a state of no equality (1.00) in 2018.

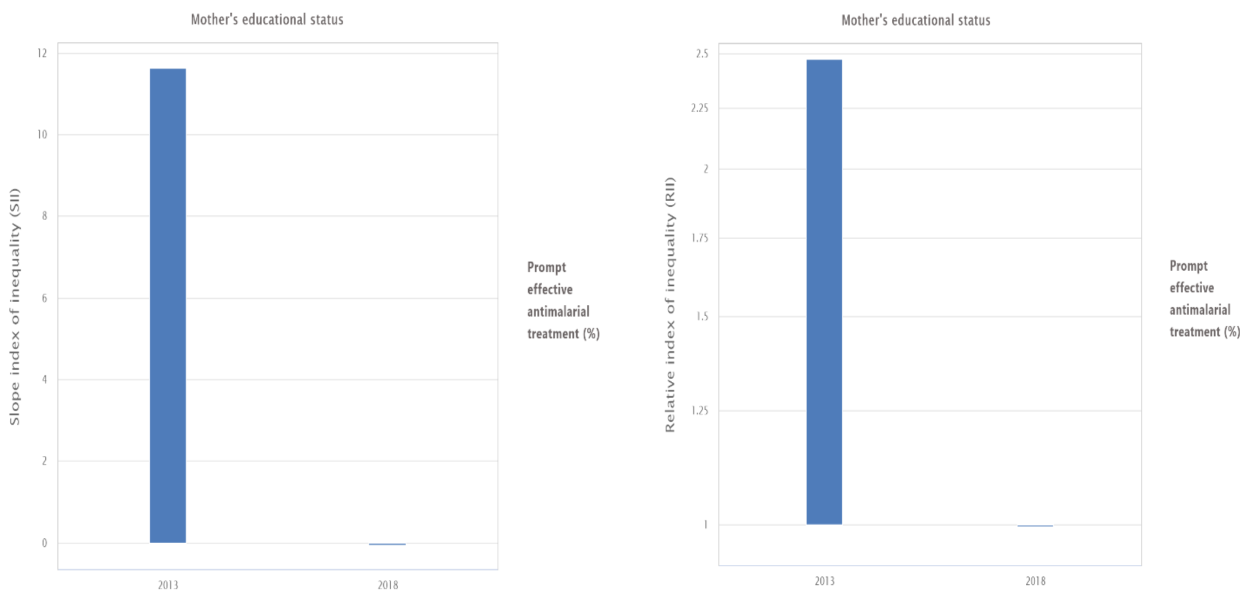

Figure 11: Change in education-based absolute (left) and relative (right) inequality in prompt effective antimalarial treatment between 2013 and 2018

In Figure 12 below, there was an increase in occupation-based absolute difference in prompt effective antimalarial treatment from -1.29% points in 2013 to 2.46% points in 2018. The relative inequality however decreased from 0.91 in 2013 to 1.06 in 2018. Using both summary measures, the concentration in prompt effective antimalarial treatment shifted from the disadvantaged group (not currently working) in 2013 to the advantaged subgroup (currently working) in 2018.

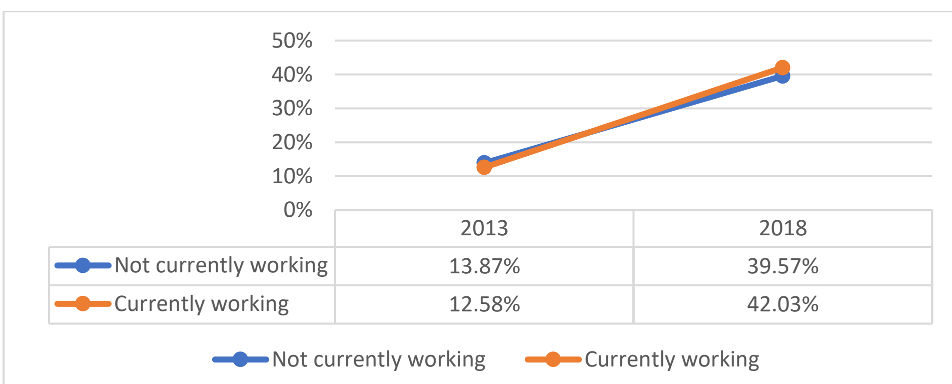

Figure 12: Change in mother's occupation-based absolute inequality in prompt effective antimalarial treatment between 2013 and 2018

CHAPTER FIVE: DISCUSSION

This study aimed to determine the proportion of under-five children with fever in Nigeria who receieved prompt effective antimalarial treatment in 2013 and 2018, to determine the pattern and measure the differences in prompt effective antimalarial treatment among subgroups of these children in 2018 and changes in the differences between two time periods (2013 and 2018). These findings could inform recommendations towards closing the inequality gap(s) in prompt effective antimalarial treatment among under-five children in Nigeria.

The study found that the proportion of the survey sample who received prompt effective antimalarial treatment was low in 2013 and 2018. This study also showed that the proportion of the study population who received prompt effective antimalarial treatment in 2018 differed from the overall proportion and varied within the population subgroups. Wealth-based and residence-based inequality in prompt effective antimalarial treatment were more pronounced. The indicator was more concentrated among under-five children with fever from wealthy homes and those who reside in the urban areas in 2018. The change in prompt effective antimalarial treatment varied for the inequality dimensions between 2013 and 2018. While the inequality increased across certain subgroups, it decreased in others. The largest decrease was seen with mother's education-based inequality where the concentration of prompt effective treatment with antimalarials among children with higher education mothers in 2013 disappeared between subgroups in 2018.

The remainder of this section will summarise the results per objective and compare to existing literature.

5.1 Proportion of under-five children with fever who received prompt effective antimalarial treatment in 2013 and 2018

This study found that the use of prompt and effective antimalarial treatment with ACTs, which are the recommended first line drug for uncomplicated malaria by the NMEP and WHO [1, 11], was low in 2013 and 2018. Recent studies on prompt and effective antimalarial treatment with ACT are scarce. The available literature within and outside Nigeria with respect to under-five children with fever who received effective antimalarial treatment revealed varying results.

Ezenduka and colleagues' study examined adherence to ACT use and reported that 93% of patients who were confirmed to have malaria in two public health facilities in South-east Nigeria received ACTs [43]. At the other extreme, Mangham reported that only 23% of people who received antimalarial in an exit interview from public hospitals, chemists, and pharmacies in Nigeria received ACTs [44]. In yet another study from Nigeria, about 37.5% of children with malaria in a community based survey received ACTs [45]. Available studies from outside Nigeria (Senegal, Tanzania, Uganda, and a multi-country study) revealed similar range (20% to 87.2%) of proportion of children with malaria who received ACT [46-49].

The study design and setting used by Ezenduka and colleagues could explain the high proportion reported in their study compared to the other Nigerian setting. Ezenduka and colleagues extracted their results from records of malaria confirmed cases from two public hospitals while the study respondents for the other Nigerian studies and the current study included people who were recruited from the community. Since facility-based surveys only capture individuals who access health facilities, the findings from the community surveys might be more representative of the proportion of children who received ACTs among those who took any antimalarial drugs.

In addition, the denominators used in the current study and the studies above vary. Some studies used children who had fever and used antimalarial, [44, 49] others used children who are confirmed to have malaria, [43, 46-48] while another study used children who had febrile illness [45]. These varying denominators can be another reason why the coverages in these studies are different. The different time periods at which the studies were conducted can also account for the varying results seen in these studies.

The finding that only about four children received ACTs out of every ten children with fever who received antimalarial in this study depicts that the prescribed antimalarial drugs are not the nationally and globally recommended drugs for uncomplicated malaria in the majority of cases. This might be one of the numerous reasons why there is still high mortality from malaria in Nigeria [7]. Another implication of the non-adherence to malaria treatment guidelines is that the malaria parasite in an infected person will not be cleared totally and such individuals continue to be a reservoir for the malaria parasite which fuels malaria transmission in the community [11, 12]. Urgent action is therefore needed to ensure that the malaria treatment guideline is adhered to if a reduction in the current malaria morbidity and mortality in Nigeria is desired.

5.2 Pattern and differences in prompt effective antimalarial treatment in 2018

Prompt effective antimalarial treatment differed from overall proportion and varied within population subgroups in this study. This finding further corroborates the known fact that decisions based on national averages only can be dangerous [36]. This is because national averages hide the differences which population subgroups experience. Malaria intervention programs should therefore make use of disaggregated data when intervention programs are been planned.

This study showed that although inequality in prompt effective antimalarial treatment occurred across all inequality dimensions studied, except mother's educational status, wealth-based and residence-based inequality in prompt effective antimalarial treatment were the most pronounced. Prompt effective antimalarial treatment was more concentrated among children from wealthy homes and those who live in urban areas.

Divergent opinions with respect to wealth-based inequality exist. Most literature support the result of this study that prompt and effective antimalarial treatment is more concentrated among the richest households compared to the poorest households. Shah and colleagues reported in their study conducted across seventeen countries using DHS data that children from wealthy homes are significantly more like to receive prompt and effective treatment compared to children from poor homes [49]. Similarly, another multi-country study across six countries using primary data also concluded that children from wealthy homes in Madagascar, Republic of Benin, and Nigeria were significantly more likely to receive ACTs compared to children from poor homes [50]. Other studies conducted in Tanzania and Zambia also support the findings from this study by concluding that inadequate household income is a barrier to accessing prompt and quality malaria treatment [51, 52].

In contrast to the report of this study, another study conducted in a South-eastern Nigerian State revealed that children from wealthy homes were not different from children from wealthy homes with respect to use of ACTs [45]. The result of this study could have been biased by the fact that the study was conducted shortly after the State Government rolled out mass malaria intervention which included the distribution of free ACTs to the general population and this might have accounted for why there was no observed wealth-based difference in this study [45].

The finding that wealth-based inequality in prompt effective antimalarial treatment is most pronounced in this study is not surprising. This is because it has been known for a long time that economic power shapes a lot of material, behavioural and psychological circumstances which affect health and healthcare [4].

Other research findings corroborate the evidence from this study which shows that prompt effective antimalarial treatment is more concentrated in the urban areas compared to the rural areas. Again, Shah and colleagues as well as Okeke and Okeibunor documented that children who dwell in urban areas were most likely to receive prompt and effective antimalarial treatment when compared to children who dwell in rural areas [49, 53]. The findings of residence-based inequality in prompt effective antimalarial treatment seen in this study and other studies also sounds to reason. Healthcare services where quality services can be accessed are more concentrated in the urban areas in Nigeria. As a result, parents and caregivers of children with fever who live in urban areas have easy access to better quality antimalarial services [54].

Surprisingly, there was no inequality in prompt effective antimalarial treatment when analysed using mother's education in this study. A likely reason for this might be that there is an increased awareness on the importance of the use of ACTs for malaria treatment among the general populace. Other studies have however shown that mother's educational status significantly predicts prompt and effective antimalarial treatment [49, 55].

Slight differences in prompt effective antimalarial treatment were also observed in the other equity stratifiers. Inequality in prompt effective antimalarial treatment across mother's occupational status was concentrated among children whose mothers were working. The occupation-based inequality can be linked to the wealth-based inequality because employment increases economic power which is linked to so many other determinants of health and healthcare.

Just like occupation-based inequality is linked with wealth-inequality, all the inequality dimensions are interlinked and do not exercise their effect on prompt effective antimalarial treatment in isolation. For example, a child who resides in a rural area might be the same child whose mother is not working and whose household is poor. Further research is recommended to describe how the inequality dimensions are interlinked within themselves and with the wider social determinants of health in determining access to prompt effective antimalarial treatment.

5.3 Changes in the differences in prompt effective antimalarial treatment between 2013 and 2018

This study showed that although there were some improvements in the proportion of children who received ACTs for malaria treatment in 2018 compared to 2013, the change in prompt effective antimalarial treatment varied for the inequality dimensions between 2013 and 2018. While the gap in some of the equity stratifiers increased between 2013 and 2018, the gap in some decreased, and the gap in others remained constant. This finding buttress the need for malaria programs to monitor how well their treatment interventions are closing the inequality gaps among subgroups of the population [36].

The most remarkable change was seen with mother's education-based inequality where prompt effective antimalarial treatment which was more concentrated among children with higher educated mothers in 2013 changed to a state of no inequality in 2018.

Wealth-based inequality dropped between 2013 and 2018 but this change remained significant while residence-based inequality increased from 2013 to 2018. The implication of this is that these two population subgroups of children should be prioritised with respect to prompt effective antimalarial treatment.

5.4 Study strengths and limitations

The use of nationally representative datasets (2013 and 2018 NDHS) is a strength for this study because the result can be generalized.

Recall bias is a limitation for this study because the NDHS data relies on mothers' ability to recall the questions asked about fever and antimalarial drugs used for their children under-five.

Not conducting a multiple regression is a limitation for this study as this would have helped to rule out the effects of confounders.

This aim of this study was to measure the differences in prompt effective antimalarial treatment among subgroups of under-five children. The study objective did not include explanation on why the differences occur and how the differences are interlinked with the wider social determinants of health.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study aimed to determine the proportion of under-five children in Nigeria who received ACTs among under-five children who had fever and received antimalarial. The study also aimed to determine the pattern and measure the differences in prompt effective antimalarial treatment among subgroups of under-five children with-fever who took antimalarial drugs and the changes in these differences over two time periods.

The findings from this study revealed that the proportion of children who received prompt effective antimalarial treatment is low and that there is inequitable distribution of prompt effective antimalarial treatment among subgroups of under-five children in Nigeria. Prompt effective use of ACTs is more concentrated among children from wealthy homes and children who live in urban areas. While some inequality dimensions for prompt effective antimalarial increased, others decreased between the two time periods. The decrease in wealth-based inequality in prompt effective antimalarial treatment is negligible while the mother's education-based status is quite remarkable.

Additional efforts are therefore needed to scale up the provision of ACTs to children who need them the most and the children from poor homes and those who live in rural areas should be prioritized in this intervention scale up.

This study also concluded that further research is needed to show how the differences in prompt effective antimalarial treatment are interlinked within themselves and the wider social determinants of health.

6.2 Recommendations

Based on the findings from this study, the following recommendations towards closing the inequality gaps in prompt effective antimalarial treatment among under-five children in Nigeria are made.

To the Government, National Malaria Elimination Programme, Malaria Partners/Donors, National Health Management Information System (NHMIS) Team:

1. This study revealed that the proportion of children who receive prompt and effective antimalarial treatment for malaria is low. This study also revealed that wealth-based and residence-based inequality in prompt effective antimalarial treatment are the most pronounced. Nigeria is a lower-middle-income country faced with limited resources, therefore provision of free ACTs for all might not be feasible. As a result of the two study findings listed above and the Nigerian context described, it is recommended that:
    a. The Government, NMEP, and Malaria Partners/Donors scale up efforts to ensure that everyone eligible for antimalarials receive the recommended ACT for uncomplicated malaria. To achieve this, ACTs can be made available at subsidized rates at all outlets (health facilities, pharmacies, chemists etc.) and a monitoring system to ensure that the outlets sell the ACTs at the recommended price should be set in motion.

b. The NMEP and Malaria Donors/Partners prioritize children from poor homes and children who reside in rural areas for ACT interventions in the scale up process.

2. This study revealed that the inequality gap in prompt effective antimalarial treatment increased for some of the inequality dimensions between 2013 and 2018. Regular measurement and monitoring could have identified this increase before the following round of NDHS survey. It is therefore recommended that in addition to using the available malaria treatment data to monitor progress towards treatment targets, the NMEP should work closely with the NHMIS Team to regularly use the available routine malaria treatment data to monitor differences in effective antimalarial treatment among population subgroups so that early detection in increasing differences can be noticed and prompt action instituted.

Recommendations for further research

1. This study only measured the differences in prompt effective antimalarial treatment using descriptive and univariate binary logistic regression. The effects of confounders were not analysed in this study. Further studies which use multiple regression technique is recommended to rule out the effects of confounders in the differences that were found in this study.
2. This study only measured the differences in prompt effective antimalarial treatment among subgroups of under-five children but did not explain why the differences occur and the complex interplay between them. Further research using a qualitative research design to explain and understand why inequality in prompt effective antimalarial treatment occur and how all the differences are interlinked is recommended in the future.

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APPENDIX 1: DATA UPLOADED TO HEAT PLUS FOR INEQUALITY ANALYSIS

1	setting	year	source	indicator_abbr	indicator_name	dimension	subgroup	estimate	se	ci_lb	ci_ub	population	flag	setting_average	iso3	favourable_indicator	indicator_scale	ordered_dimension	subgroup_order	reference_subgroup
2	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	10.99	2.15	7.4	16.0	199		12.96	NGA	1	100	1	1	0
3	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	7.04	2.08	3.9	12.4	221		12.96	NGA	1	100	1	2	0
4	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	14.06	3.06	9.0	21.2	264		12.96	NGA	1	100	1	3	0
5	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	13.9	2.68	9.4	20.0	255		12.96	NGA	1	100	1	4	0
6	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	17.66	3.10	12.4	24.6	250		12.96	NGA	1	100	1	5	0
7	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Child's se	Female	12.28	1.74	9.3	16.1	570		12.96	NGA	1	100	0	0	0
8	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Child's se	Male	13.58	1.75	10.5	17.4	619		12.96	NGA	1	100	0	0	1
9	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Geopolitic	Southern	14.01	2.35	10.0	19.3	477		12.96	NGA	1	100	0	0	0
10	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Geopolitic	Northern	12.26	1.66	9.4	15.9	712		12.96	NGA	1	100	0	0	1
11	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Place of re	Rural	11.59	1.74	8.6	15.5	685		12.96	NGA	1	100	0	0	0
12	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Place of re	Urban	14.82	2.23	11.0	19.8	504		12.96	NGA	1	100	0	0	1
13	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Mother's e	No educa	9.27	1.73	6.4	13.3	452		12.96	NGA	1	100	1	1	0
14	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Mother's e	Primary	11.92	2.60	7.7	18.0	227		12.96	NGA	1	100	1	2	0
15	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Mother's e	Secondar	16.91	2.36	12.8	22.1	404		12.96	NGA	1	100	1	3	0
16	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Mother's e	More tha	15.88	5.33	7.9	29.3	107		12.96	NGA	1	100	1	4	0
17	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Child's ag	Less thar	13.48	1.77	10.4	17.3	576		12.96	NGA	1	100	0	0	0
18	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Child's ag	Greater t	12.48	1.77	9.4	16.4	613		12.96	NGA	1	100	0	0	1
19	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Mother's e	Not curre	13.87	2.12	10.2	18.6	353		12.96	NGA	1	100	0	0	0
20	Nigeria	2013	DHS	ml13erec_3	Prompt effectiv	Mother's e	Currently	12.58	1.69	9.6	16.3	836		12.96	NGA	1	100	0	0	1
21	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	37.3	2.83	31.9	43.0	640		41.32	NGA	1	100	1	1	0
22	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	43.22	3.03	37.4	49.2	680		41.32	NGA	1	100	1	2	0
23	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	37.06	2.56	32.2	42.2	601		41.32	NGA	1	100	1	3	0
24	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	41.62	3.20	35.5	48.0	493		41.32	NGA	1	100	1	4	0
25	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Househol	Quintile	51.64	4.25	43.3	59.9	359		41.32	NGA	1	100	1	5	0
26	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Child's se	Female	39.39	1.94	35.6	43.3	1356		41.32	NGA	1	100	0	0	0
27	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Child's se	Male	43.17	1.93	39.4	47.0	1417		41.32	NGA	1	100	0	0	1
28	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Geopolitic	Southern	42.61	2.20	38.4	47.0	787		41.32	NGA	1	100	0	0	0
29	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Geopolitic	Northern	40.81	2.09	36.8	45.0	1986		41.32	NGA	1	100	0	0	1
30	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Place of re	Rural	38.67	2.04	34.8	42.7	1783		41.32	NGA	1	100	0	0	0
31	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Place of re	Urban	46.1	2.67	40.9	51.4	989		41.32	NGA	1	100	0	0	1
32	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Mother's e	No educa	42.83	2.37	38.3	47.5	1283		41.32	NGA	1	100	1	1	0
33	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Mother's e	Primary	32.68	2.80	27.4	38.4	439		41.32	NGA	1	100	1	2	0
34	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Mother's e	Secondar	42.37	2.40	37.7	47.1	874		41.32	NGA	1	100	1	3	0
35	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Mother's e	More tha	46.68	5.32	36.5	57.1	176		41.32	NGA	1	100	1	4	0
36	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Child's ag	Less thar	40.75	2.00	36.9	44.7	1096		41.32	NGA	1	100	0	0	0
37	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Child's ag	Greater t	41.7	1.88	38.1	45.4	1677		41.32	NGA	1	100	0	0	1
38	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Mother's e	Not curre	39.57	2.47	34.8	44.5	798		41.32	NGA	1	100	0	0	0
39	Nigeria	2018	DHS	ml13erec_3	Prompt effectiv	Mother's e	Currently	42.03	1.81	38.5	45.6	1975		41.32	NGA	1	100	0	0	1
40																				