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Sociodemographic Factors Associated With Childhood Vaccination Status in Sokoto State, Nigeria

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Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Public Health

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Abstract

Immunization remains one of the most successful and cost-effective public health interventions worldwide. Sokoto state recorded the lowest childhood vaccination completion rate among the 37 states in Nigeria during Nigeria's 2018 demographic and health survey with only 5% of children aged 12-23 months having had full childhood vaccination. The factors associated with the state's low childhood vaccination status have not been explored. The study examined the relationship between the sociodemographic factors including parents' socioeconomic and ethnoreligious factors, place of residence, and children's biological characteristics and childhood vaccination status in Sokoto state. The social ecological model provided the framework for the study. Data were obtained from the 2018 demographic and health survey. Descriptive analysis, Pearson chi-square, and simple and multiple logistic regression analyses were used as tools for data analysis using sample size of 1883 to examine the association between the independent and dependent variables. The findings of the study revealed that parents' educational level, occupation, family wealth index, ethnicity, and sex of children have significant positive effects on childhood vaccination status in Sokoto state, Nigeria, whereas religion, place of residence, and birth order do not have a significant effect. The study findings have the potential for positive social change if public health interventions could target both male and female children born to uneducated Hausa/Fulani ethic group in Sokoto state to enhance childhood vaccination status and reduce the incidence of child mortality from vaccine-preventable diseases.

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Dedication

The dissertation will be dedicated first to the Almighty God and to my family.

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My gratitude goes to Almighty God for seeing me through the trying period of this study and research work. My sincere appreciations firstly goes to my supervisors Drs. Howell Sasser and David Segal for their guidance, scrutiny, and prompt feedbacks/corrections from the early phase of preparation to the end of the dissertation. To all tutors of the Department of Health Sciences and Public Health and other staff of Walden University, I say thank you for the support. This modest achievement would have been very difficult but for the unwavering support and encouragement from my darling wife, Saratu, and my children Ijuptil, Jafiada, Janada, and Israel. I also appreciate all other family members for their consistent prayers and support during all these years of burning midnight candles. I appreciate all friends and course mates for the support and encouragement to continue pushing until victory is achieved.

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Chapter 1: Introduction to the Study

Immunization is the process of fortifying an individual's immune system for protection against invading microorganisms through the administration of vaccines. The World Health Organization (WHO) has described vaccines as one of the most cost-effective public health investments with clearly defined target groups requiring no change in lifestyle since they could be delivered during outreach immunization services (WHO, 2000a). Vaccines protect a person against subsequent infections or diseases by stimulating the immune system of the body (WHO, 2000a). WHO also describes immunization as one of the most accessible public health interventions to even the most vulnerable populations and hard to access communities (WHO, 2018). It is estimated that immunization averts over two to three million deaths each year globally; hence, it is a useful tool to control or eliminate life-threatening infectious diseases including tetanus, measles, poliomyelitis, pneumonia, diphtheria, hepatitis B, yellow fever, and tuberculosis (WHO, 2018). Since the introduction of the global immunization program, there has been a remarkable reduction in the incidences and prevalence of vaccine-preventable diseases, as seen with the eradication of smallpox in the 1980s (Blackman, 2008). Between the year 2000 and 2009, there was a dramatic demonstration of the effectiveness of immunization in the African region with the reduction of deaths from measles by over 89% (Murele et al., 2014).

Between the year 2000 and 2012, the number of endemic African countries with wild poliovirus (WPV)transmission reduced from 12 to only one (Nigeria; Murele et al., 2014). Similarly, the number of children paralyzed by the polio disease decreased in 2012

by 63%, when only 128 confirmed polio cases were reported in three endemic countries of Nigeria, Chad, and Niger republics (Murele et al., 2014). The Center for Disease Control and Prevention (CDC), WHO, and other public health agencies continue to rank immunization among the best medical discoveries due to its proven effectiveness (CDC, 2005b; WHO, 2009). Good immunization coverage has been identified by the Global Polio Eradication Initiative (GPEI) as one of the four strategies to achieve the eradication of poliomyelitis disease, thereby underscoring the importance of vaccination in preventing childhood morbidity, mortality, and disabilities (WHO, 2009). Immunization coverage depends on the proportion of children fully vaccinated for their ages. The recommendations of WHO for basic childhood vaccination consists of polio, pentavalent (diphtheria, tetanus, pertussis, hemophilus influenza, and hepatitis B vaccine), measles, and Bacillus Calmette-Guerin (BCG) for prevention against common childhood diseases. Nigeria's immunization schedule classifies a child as fully vaccinated before the age of 12 months (or first birthday) upon collecting a dose of BCG and the three doses of diphtheria-tetanus-pertussis vaccine (DTP), which is now referred to as pentavalent vaccine (National Primary Health Care Development Agency [NPHCDA] Nigeria, 2017). The child will also collect at least three doses of oral polio vaccine (OPV) and a dose of measles vaccine (NPHCDA, 2017). The pentavalent vaccine is a five-vaccines-in-one combination against diphtheria, tetanus, whooping cough, hepatitis b, and Hemophilus influenza type b, all given as a single dose (WHO, 2018a). The third dose of the diphtheria-tetanus-pertussis vaccine (DTP3) is used in Nigeria as a proxy for vaccination coverage and performance (Wariri et al., 2019). In Nigeria and most other sub-Sahara

African countries, the proportion of children receiving the recommended vaccines as per the vaccination schedules has been very low over the last decade (Wariri et al., 2019; WHO, 2018). For instance, in 2017, over 19.9 million children worldwide missed routine immunization services, with over 60% living in the 10 resource-poor sub-Sahara African and Asian countries (WHO, 2018). With improved routine immunization coverage, an additional one and a half million deaths could be prevented annually (WHO, 2018). Despite implementing many strategies, programs, and policies by the Nigerian government since 1978, childhood immunization coverage in Sokoto state has remained the lowest in the country in the last decade (Adedokun et al., 2017; National Population Commission (NPC) & ICF Macro, 2018; Tsafack & Ateudjieu, 2015).

The aim of this study was to assess the sociodemographic factors associated with completion of childhood vaccination in Sokoto State, Nigeria and recommend ways of improving vaccine uptake to boost immunity status and reduce childhood mortality and disability. The finding of this study may provide additional information for strategic planning of immunization services in Sokoto state. This section of the dissertation will discuss the problem statement, the purpose of the study, research questions, hypothesis, theoretical foundations for the study, nature of the study, and literature search strategy. The next chapter will focus on a literature review to define significant concepts, assumptions, and the scope of the study as defined in the limitation and delimitations.

Background of the Study

In 1974, WHO launched the Expanded Program on Immunization (EPI) with a recommendation that every country should implement it to reach all eligible children with

potent vaccines (Itimi et al., 2015). Nigeria first launched the EPI in 1979 and re-launched it in 1984, when only 10% achievement in immunization coverage (Sorungbe, 1989). Since Nigeria and other countries launched the EPI, some efforts were made to meet the expected immunization targets and deadlines set by WHO, leading to initially encouraging results that were not sustainable in most states including Sokoto (Adedokun et al., 2017; Blackman, 2008). The United Nations general assembly special session set a goal for full immunization of children aged 11-23 months old at a minimum coverage of 90% nationally and 80% in all districts or equivalent administrative unit by the year 2010 (WHO, 2018). Despite the global progress in the use of immunization as a child survival strategy, coverage estimates for all vaccines administered during routine vaccination for children in Nigeria and other low resource countries are still below the 80% level (Adedokun et al., 2017). In 2011, Nigeria accounted for 14% of incompletely vaccinated children globally (Adedokun et al., 2017). Despite the implementation of various strategies to improve vaccination status, including mass campaigns like the polio house-to-house or door-to-door immunization exercises at the national and sub-national levels in Nigeria, the coverage remains low, leading to high childhood mortality (Ngowu et al., 2008). Achieving good immunization coverage is one of the critical indicators of the Millennium and Sustainable Development Goals (MDG 4 and SDG 3) respectively including reduction of childhood morbidity and mortality (Negussie et al., 2016).

Sokoto is one of the seven states of the north-west zone in Nigeria. The total population of the state is 3,702,676 (projected from the last national census of 2006), with under-5-year estimates of 748,444 (Ibrahim et al., 2016; NPHCDA, 2018). The state

is demarcated into 23 districts or local government areas (LGAs) and has landmass of 32,000 square kilometers. The states bordering Sokoto includes Zamfara to the south-east and Kebbi state to the south-west, while Niger republic is to the north (Ibrahim et al., 2016). The location of Sokoto state is between latitude 13005'N and longitude 05016'E. The rainy season is usually short, running between May and June to the end of September or early October. The duration of the dry season is generally longer, with riverine flood plains providing opportunities for dry season farming. The predominant inhabitants are the Hausa-Fulani tribe who mostly practice the religion of Islam and speak the Hausa dialect, although English remains the official language. Most of the citizens are subsistent farmers and cattle breeders, while few run various and mostly petty businesses. Therefore, agriculture remains the pillar of the economy (National Bureau of Statistics [NBS] Nigeria, 2015).

The successful eradication of smallpox and a remarkable reduction in incidences of measles and other VPDs are associated with the introduction of vaccines into public health interventions (Adedokun et al., 2017). In the African region, the measles vaccine, for instance, has reduced by about 90% mortality from the disease between the year 2000 and 2009 (Adedokun et al., 2017). Despite these achievements, the uptake of immunization remains sub-optimal in Sokoto and other parts of Nigeria and sub-Saharan Africa, with the attendant effect of recurrent outbreaks of VPDs (Adedokun et al., 2017; Tsafack & Ateudjieu, 2015). Several factors have been identified to hinder the optimum uptake of routine and supplemental vaccines in Nigeria and other low resource countries including problems of healthcare service providers like limited number and their

inequitable distribution, poor remuneration resulting in frequent industrial actions and locking up of health facilities (Adedokun et al., 2017). Additional challenges include non-availability of adequate vaccines and logistics supplies worsened by poor cold chain system to maintain vaccine potency (Kimmel et al., 2007). Adedokun et al. (2017) identified low maternal or caregiver knowledge on the importance of accepting and completing vaccination as per schedules, hesitancy due to fear of side-effects, long wait times for vaccinations in the health center, economic and geographic inaccessibility, and the poor attitudes of service providers. Other researchers identified low wealth index of families, higher birth order and sex of the child (female gender), religious affiliation, place of delivery, age, antenatal care attendance by the mother, and so on (Gidado et al., 2014; Lakew et al., 2015; Ophori et al., 2014). Recent studies examined the historical and political context of northern Nigeria, where some parents opposed vaccinations of their children due to lack of trust in government and the fear of western countries reducing Muslim populations through the administration of contaminated vaccines to "sterilize" children (Murele et al., 2014; Obadare, 2005). Likewise, Oluwadare (2009) argued that in Ekiti State, south-west Nigeria, while some parents have a good knowledge of the benefits of immunization, they still opposed vaccines due to ethnoreligious reasons. In Ethiopia, low maternal education and wealth index levels, lack of antenatal care attendance, and far distance to vaccination points contributed to sub-optimum immunization coverage of only 24.3% and high childhood mortality of 88 deaths per 1,000 live births (Lakew et al., 2015).

Problem Statement

Sokoto state has consistently recorded the lowest immunization coverage in different surveys conducted in Nigeria over the last decade (NPC Nigeria& ICF International, 2018). Attaining good immunization coverage is an important indicator to monitor improvement in child survival by reducing child morbidity and mortality (NPC & ICF International, 2018). During the last three consecutive Nigeria's demographic and health surveys (NDHS) conducted in 2008, 2013, and 2018, Sokoto recorded the lowest immunization coverage (NPC & ICF International, 2014). Additionally, the state had the worst performance in immunization in the 2015 malaria indicator survey (MIS) and the 2014 national nutrition and health survey using the standardized monitoring and assessment of relief and transitions (SMART) methods (National Bureau of Statistics [NBS] Nigeria, 2015); WHO, 2016a). For instance, in both the 2013 and 2018 NDHS, Sokoto state recorded only 2.6% and 5% respectively as the lowest coverage in Nigeria, far below the national average of 67% and much lower than the expected target of 95% (NPC & ICF International, 2013, 2018). The SMART survey coverage result showed a wide variation in the vaccination coverage across the 37 Nigerian states, ranging from the lowest 2% in Sokoto to the highest 92% in Osun state. The poor immunization status of Sokoto and other states in Nigeria over the last few years has been identified as the likely factor associated with the frequent outbreaks of vaccine-preventable diseases (VPDs) and increased childhood mortality and disability (Adeloye et al., 2017; Ahmed et al., 2018; Ibrahim et al., 2016). Ophori et al. (2018) and other researchers reported that states in Nigeria like Sokoto that have poor vaccine uptake have continued to manifest evidence of

active transmission of infectious viruses like the poliovirus due to low herd immunity. As a result of low population immunity, Sokoto state was listed among the remaining six polio sanctuaries in Nigeria in 2010 with 21 confirmed WPVs (Ophori et al., 2018). Similarly, outbreaks of circulating vaccine-derived polioviruses and WPVs still thrive in endemic countries like Afghanistan and Pakistan as a result of low herd immunity from poor immunization coverage (Jorba et al., 2018). The research community is yet to identify the factors associated with the consistently poor immunization coverage in Sokoto state. Several studies have reported on factors associated with low completion rate of childhood vaccination in different parts of Nigeria and even in the north-west zone. Unfortunately, no study has determined the factors associated with consistently low completion rate of childhood vaccination in Sokoto state, hence the need for this research.

Purpose of the Study

The purpose of this study is to examine the underlying sociodemographic factors associated with the persistently low childhood vaccination status in Sokoto state, Nigeria. It is essential to explore the relationship between parents' socioeconomic factors (educational level, occupation, and wealth index) and ethnoreligious affiliation (tribe/ethnicity and religious belief) with childhood vaccination status in Sokoto state, Nigeria. Additionally, the relationship between children's biological characteristics (sex and birth order) and vaccination status was explored. Understanding the factors that enhance or impede access to vaccines, including the distance to the nearest health center offering immunization services, could make parents/caregivers increase vaccine uptake

and address accessibility challenges. The finding from this study may contribute to understanding the role of socio-demographic factors, ethnoreligious characteristics, and children's biological characteristics in affecting the optimum uptake of vaccines. The conclusions of this study could help guide community level efforts to raise awareness and knowledge to trigger demand for vaccines to increase and sustain state-specific or localized immunization coverage. Addressing these barriers could boost herd immunity to reduce the burden of vaccine-preventable childhood diseases and improve child health and survival. The results of this study could provide additional strategies to address the factors affecting the optimum uptake of vaccines according to the recommended immunization schedule in Sokoto state by government officials, health care workers, and other stakeholders including the civil society and other non-governmental organizations.

Research Questions and Hypotheses

Low immunization coverage and frequent outbreaks of childhood VPDs have been of concern to the government and people of not only Sokoto state but the whole country (Sokoto State Ministry of Health [MOH], 2017). At the state and in all the 23 districts or LGAs, serious concerns have been raised on the poor immunization status and the frequent outbreaks of VPDs including measles and tuberculosis (Sokoto State Ministry of Health, 2017). In studies done in Osun state, south-west Nigeria to address the factors associated with low immunization coverage, Adedire et al. (2016) reported that encouraging mothers to attend antenatal care and improving their awareness levels on the importance of immunization helped to improve vaccine uptake and immunization coverage. In Ethiopia, Negussie et al. (2016) identified vaccine stock-outs and mothers'

frequent movements as major factors leading to missing of vaccine doses during scheduled sessions and failing to complete childhood vaccinations. A similar study needs to be conducted in Sokoto State to identify the factors associated with the consistently low immunization coverage in the country.

The following are the research questions that drove my dissertation:

RQ1: Are there relationships between parents' socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status in Sokoto State, Nigeria?

$H_0$1: There is no relationship between parents' socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status in Sokoto State, Nigeria.

H_a1: There is a relationship between parents' socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status in Sokoto State, Nigeria.

RQ2: Are there relationships between parents' ethnoreligious affiliation (tribe/ethnicity and religious belief) and childhood vaccination status in Sokoto State, Nigeria?

$H_0$2: There is no relationship between parents' ethnoreligious affiliation (tribe/ethnicity and religious belief) and childhood vaccination status in Sokoto State, Nigeria.

H_a2: There is a relationship between parents' ethnoreligious affiliation (tribe/ethnicity and religious belief) and childhood vaccination status in Sokoto State, Nigeria.

RQ3: Are there relationships between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria?

H_03: There is no relationship between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria.

H_a3: There is a relationship between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria.

RQ4: Are there relationships between a child's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria?

H_04: There is no relationship between a child's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria.

H_a4: There is a relationship between a child's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria.

Theoretical Frameworks

The Social Ecological Model (SEM)

The Social Ecological Model (SEM) is the theoretical framework for the study to explore the association between social-demographic factors and childhood vaccination status. Urie Bronfenbrenner developed the ecological systems theory (EST)to study how sociodemographic factors influence a child's life and behavior including getting vaccinated, going to school, and so on (Bronfenbrenner, 1977, 1979). The adaptation

called the EST provides a framework for understanding how a child's development and growth depends on factors innate to the child and their environment. The model is used to study the interaction between an individual or a child with the social environment towards the improving conditions of life (CDC, 2015). The SEM offers a framework for stakeholders to plan and determine the relevant activities at the four social and environmental factors: individual (intrapersonal), relationship (interpersonal), community (organizational and social networks), and society/public policy (CDC,2015; McLeroy et al., 1988).

All the variables of the study are extracted from the concepts of this theory. SEM was developed to study the reciprocal interactions between individuals and their environment. The SEM is used to study how an individual's behavior is integrated in a dynamic network of intrapersonal characteristics, interpersonal relationships, institutional factors, community factors, and public policy. The environment influences an individual just as the individual also influences their environment in a reciprocal interaction. In this model, the environment is comprised of different overlapping levels. The intrapersonal level (microsystem) describes the immediate environment such as family, school, peers, church, and so on. The mesosystem or interpersonal relationship as the second layer describes the interconnection between the mesosystem, e.g. the relationship between home and school. The exosystem describes the links between social settings that do not involve the child directly. For example, a child's experience at home may be influenced by their parent's experiences at work. The macrosystem describes the culture that influences the development of a child and evolves from generation to generation. The

chronosystem is the public policy as shaped by local, state, and federal laws to influence all layers.

The SEM provides the foundation of inquiry into the multiple levels of influence that shape and is shaped by the social environment. An individual's intrapersonal, interpersonal, organizational, and the society are the four-level interrelated social ecology model shaping health behaviors and outcomes (CDC, 2007). The SEM holds that humans encounter different environments throughout their lifespan that could have an impact on their behaviors in varying degrees. The SEM has five ecological systems including the microsystem, the mesosystem, the exosystem, the macrosystem, and the chronosystem. These five systems play critical roles in shaping the psychological development of children (Darling, 2007; Hong & Eamon, 2012).

The microsystem's setting refers to the immediate environment where a child lives with family, classroom, friends, and neighbors. The microsystem is the closest layer to the child because it has the inner structures where the child has direct contact with. The mesosystem serves as the layer providing the needed connection between the various structures of the child's microsystem (Berk, 2000). The mesosystem serves as the link between a child's microsystem and other systems by closely interacting or connecting with each other, like a student's parents and their school (Darling, 2007; Hong& Eamon, 2012). The external environment with no direct bearing on the child is the exosystem, including parent's workplace or schedules which affect the child (Bronfenbrenner, 1997). The macrosystem is considered as the outermost layer in the child's environment, including the cultural values and broader social attributes (Bronfenbrenner,1977). At the

various levels within the SEM model, positive or negative contributions to the child can result. Within the context of strengthening immunization services in Sokoto state, and other states in Nigeria, all the layers of the child's environment could influence completion or lack of completion of childhood vaccination.

Within the context of strengthening immunization services, all the layers of the child's environment could influence completion or lack of completion of childhood vaccination. In this study, the key independent variables are mapped to the different levels within the SEM including:

a) INDIVIDUAL: Sex, Birth Order
b) RELATIONSHIP: Religion, Cultural affiliation
c) COMMUNITY: Place of Residence, and
d) SOCIETAL: Religion, Residence.

Using the SEM, it is pertinent to recognize how childhood vaccination is perceived by the various cadres of people or the population in Sokoto state, Nigeria. The roles played by the various elements within the four-level SEM concerning childhood vaccination status and the impact on child health. Reports of vaccine hesitancy as a negative behavior are common in Sokoto and other states in northern Nigeria (WHO-Nigeria, 2010).

Nature of the Study

The method of inquiry of this study is quantitative cross-sectional survey design of the immunization status of children aged 12-23 months old in Sokoto state using the existing dataset from the NDHS2018. The rationale for the selection of cross-sectional quantitative survey design is because of its broader applicability and provision of

numerical descriptions of trends and measures the level of occurrence of an event (Creswell, 2009; Siegel & Lotenberg, 2007). In cross-sectional studies, there is the likelihood of obtaining the desired results of the survey faster (Creswell, 2009). Additionally, this study design type is appropriate to investigate the associations between risk factors and a particular outcome to generate further hypotheses for future research (Creswell, 2009; Siegel & Lotenberg, 2007). The study involved secondary analysis of the retrieved dataset from the 2018 NDHS with permission of the United States Agency for International Development (USAID), the primary dataset holders. The SPSS version 21 was used to analyze the data (IBM, 2012) to investigate the sociodemographic factors associated with low childhood vaccination status in Sokoto state, Nigeria. The methodology chosen helped to describe the pattern of the relationship between variables of interest as seen in near-natural and prevalence studies (Frankfort-Nachmias & Nachmias, 2008). Some of the advantages of using this method include having limited ethical issues, easy and quick to implement, cost-effective, and easy to replicate (Frankfort-Nachmias & Nachmias, 2008; Hennekens & Buring, 1987). The key independent variables studied were parents' socioeconomic factors (educational level, income, and family wealth index), ethnoreligious affiliation (ethnicity and religion), place of residence, and children's biological characteristics (sex and birth order) on the dependent variable (childhood vaccination status).

The method of sample collection for the 2018 NDHS was done using a stratified, two-stage cluster design where the enumeration areas (EAs) were the sampling units for the first stage. The second stage involved listing all households in each of the 1,400

selected EAs to get a representative sample of approximately 42,000 households for the survey. All women and men aged 15-49 and 15-59 years respectively who were either permanent residents of the selected households or visitors who stayed in the household the night before the survey were eligible and were interviewed. Using the Woman's Questionnaire, information was collected from all eligible women aged 15-49 on their background characteristics (including age and education), birth history and child mortality, antenatal delivery, postnatal care, vaccinations and childhood illnesses, and fertility preferences (including desire for male children). The sample size used in the 2018 NDHS was larger than the ones used in the five previous surveys, covering a total of 1,400 clusters across the country. Social and behavior change communication questions on malaria, minimum dietary diversity among women, fistula, and disability were included as requested by various stakeholders. The secondary data were analyzed using SPSS software by initially conducting an exploratory data analysis (EDA) to free the data from all types of errors. Descriptive analyses were then used to describe the patterns for all variables followed by inferential statistics to test the hypotheses of the study.

Operational Definitions of Terms

Childhood vaccination schedule: Refers to series of vaccinations that includes the timing of all the recommended vaccine doses depending on the country of residence.

Children's biological characteristics: Refers to the sex and age of the child as well as birth order in the family.

Dependent variable: Refers to the childhood vaccination status measured by proportion of children receiving full doses of BCG, Penta, OPV, and measles.

Ethnoreligious background: Refers to the religious affiliation and tribe of the respondents.

Full/complete immunization: Refers to the completion of the required doses of vaccines as per the standard schedule including a dose of BCG, three doses of DPT-containing vaccine and oral polio, and a dose of measles vaccines by the age of 12-23 months.

Fully vaccinated child: Refers to a child who received a BCG, at least three doses of pentavalent, PCV, and OPV, a dose of IPV, and measles vaccines by the age of 12 months. A fully vaccinated child is one who received all recommended doses as per schedule.

Immunization defaulter: Refers to the missing of the recommended vaccines at a particular time as per the schedule.

Incomplete/partial immunization: Refers to inability to receive all basic vaccinations by age 12-23 months (one dose of BCG vaccine, three doses of DPT-containing vaccine, three doses of OPV [excluding polio vaccine given at birth], and one dose of measles vaccine), as per Nigeria's immunization schedule.

Incompletely vaccinated child: Refers to a child who started to receive some of the recommended vaccines as per the schedule but did not complete all.

Independent variables: Refers to parents' socioeconomic status, ethnoreligious background, place of residence, and children's biological characteristics.

Place of residence: Refers to place of residence of parents (rural or urban areas).

Socioeconomic status: Refers to the educational level, occupation, and family wealth index of the respondents (parents/caregivers).

Unvaccinated child: Refers to a child who did not receive any dose of the recommended vaccines as per the schedule.

Measurement of Variables and What the Scores Represent

Assumptions of the Study

In this study, I assumed that the 2018 NDHS was carried out using probability-sampling technique being a cross-sectional study. I further assumed that participants understood the various variables from the explanations given by the interviewers. That the data entry process was done with minimal errors was another assumption. I also assumed that the absence of missing data occurred randomly and did not bias the study. For the unbiased study of the variables, I made the assumption that the data set had enough cases and variables. I assumed that the NDHS secondary dataset used contained the expected dependent and independent variables. It was assumed that the custodians of the dataset willingly released it upon request for analysis. That vaccination status of a child was assessed from vaccination history recalled by mothers' oral history or from the child's immunization card and the interviewers documenting wholly and accurately the vaccination status were further assumptions. Finally, it was assumed that if significant obstacles to completion of vaccinations were removed, the completion and immunization rates would increase.

Scope and Delimitations

The study addressed the complete childhood vaccination status in Sokoto state, Nigeria by understanding the relationship between some sociodemographic factors including parents' socioeconomic factors (income, occupation, and educational level), ethnoreligious affiliation (ethnicity and religion), place of residence (urban or rural), and children's biological characteristics (sex and birth order) and childhood vaccination status as the dependent variable. This study analyzed secondary dataset from the 2018 NDHS using the SEM as the theoretical framework. The findings from the study could not be generalized to other populations in Nigeria but only to Sokoto state because it was limited to the state. As a study using secondary data, there was no primary data collection or direct contact with the participants in the study leading to a time lag between the period of the survey and the use of the dataset for secondary analysis. The delimitations of the study include being a quantitative cross-sectional descriptive study that used secondary data with likely inherent errors. There were no control groups for comparison or interventions for temporal analysis. Only the variables available in the dataset were analyzed. The study is delimited by the number of questions in the data collection tools and the sample size used for the national survey. The only information collected by the data collectors during the study in 2017-2018 was used, hence the study is delimited by the time of data collection and by the findings in the child health cards when the research was done.

Limitations

This study has several limitations including the use of secondary data collected by other researchers, thereby making it difficult to ascertain the integrity, reliability, and validity of the data, and sensitivity of the scales, thus limiting the control of confounders (Smith et al., 2011). Some variables that might have added more value to the study may have been missed in the secondary data. The data were collected for states in Nigeria only, and so the result is not generalizable to other populations with the different socio-cultural background. Missing data might affect the inferences drawn from this study, and I could not modify the dataset to ensure there were no missing data. Different researchers and interviewers collected the primary data and the same with statisticians and data clerks who inputted the data whose capacity might not be optimum. There was the likelihood of information bias resulting from varying levels of recall capacities of the respondents that could hurt the findings of the study. Over the years since the collection of the dataset, its quality could be altered by manipulations at various levels. Lastly, although one could have established the relationship between dependent and independent variables, it was difficult to establish causality using the secondary data and cross-sectional study design. A qualitative study is required to understand why even some educated mothers oppose childhood vaccination. Quantitative studies like this one cannot provide answers to such problems that are attitudinal or behavioral.

Significance of the Study and Potential for Social Change

The purpose of the study was to explore and describe the sociodemographic factors associated with complete childhood vaccination status in Sokoto state, Nigeria.

The findings of this study could serve as additional sources of information for policymakers on the sociodemographic factors associated with complete childhood vaccination status for implementation of specific public health interventions to address the problem. With such a better understanding of the challenges, healthcare workers, policymakers, and other stakeholders at various levels are better positioned to implement community-based participatory activities to achieve the desired childhood vaccination coverage of at least 90%. The findings added to the body of knowledge and potential references for other scholars seeking to pursue academic research in a similar area. The results guided planning to improve immunization programs in the state and provide an evidence-based understanding that can influence programmatic planning and client decision. The findings could further help to bridge the gap in the literature and advance scientific knowledge in the field of immunization, not only in Sokoto state but also in other parts of Nigeria. The recommendations from the study could guide decisions, strategies, and resource investments for childhood vaccination programs to improve population immunity and reduce morbidity, mortality, and disability from VPDs (Ahmed et al., 2018).

The study has the potential for social change if public health interventions could target children born to uneducated parents and poor families from the Hausa/Fulani Muslim communities residing in rural areas in Sokoto state to enhance complete childhood vaccination to reduce the incidence of child mortality from VPDs. The results could be useful for developing health messages regarding VPD prevention and control (Siddiqui et al., 2016). If caregivers and parents have adequate knowledge that most

childhood diseases are easily preventable with full vaccination and other preventive measures, then they are likely to change negative perceptions of vaccines and other child-survival interventions including family planning, nutrition, antenatal care, and so on. This, in turn, will promote the attainment of sustainable development goals and other global targets to reduce morbidity, mortality, and disability from diseases like polio, measles, tuberculosis, leprosy, and so on. Studies done in other countries identified a couple of social, political, and economic factors that are associated with reduced childhood immunization status (Mbengue et al., 2017; Murele et al., 2014; Negussie et al., 2016). Conducting a similar study in Sokoto state will provide the opportunity to explore the factors associated with low immunization coverage to improve population immunity and reduce the burdens of diseases (Abdulraheem et al., 2011). The quest to fill the existing gap in the literature by studying those factors associated with the poor childhood vaccination status in Sokoto state cannot be over-emphasized. With good population immunity, children are usually much healthier and better able to contribute to positive social change rather than being liabilities on their families and society due to deformities or disabilities from VPDs, with attendant effects of roadside begging for alms as seen in Sokoto and other states in Nigeria (WHO & UNICEF, 2014). As healthy individuals in the continuum of life, children in Sokoto state are likely to learn better to acquire professions and intellectual foundations as good citizens who can advance better societies. Such children will contribute ideas and support community-based interventions to build community, create the opportunity for wealth, and improve human dignity. In addition to the positive social change listed above, the outcome of this study could guide

some interventions to address identified gaps, add to the body of knowledge, and advance the academic community.

Summary

Despite the concerted efforts to strengthen childhood vaccination status and the implementation of various strategies including mass campaigns like the Immunization Plus Days at the national and sub-national levels in Nigeria, vaccine uptake remains sub-optimum in different parts of Nigeria and other resource-poor nations. While the immunization coverage rates of most other states including those in the same northwest zone of Nigeria have been on the increase from most recent surveys, Sokoto state has consistently showed very low performance, with most children remaining unvaccinated against childhood diseases (NDHS, 2018). It is, therefore, essential to identify the sociodemographic factors associated with low childhood vaccination status in Sokoto state to add to the body of knowledge of the various strategies or interventions to improve immunization coverage. The study analyzed the secondary data from the 2018 NDHS. The theoretical framework that guided the study was the SEM, as discussed in more detail in this chapter together with the scope, delimitations, and limitation. The outcome of the study has implications for social change including the provision of more information to policy makers and enhancing awareness on the importance of immunization. In Chapter 2, a review of the existing literature and evolution on development of vaccines appear, including an assessment of the barriers to vaccine uptake. In most low-resourced countries including Nigeria, there exists gaps in the understanding of the importance of immunization. Chapter 3 focuses on research methods

for the study, while the findings from the study are presented in Chapter 4. The final chapter is devoted to in-depth discussion about the study's findings, the implications for social change, recommendations for action, as well as suggestions for future research.

Chapter 2: Literature Review

Globally, over the last 3 to 4 decades, vaccines have helped to a great extent to reduce childhood morbidity and mortality, especially in the low-resource sub-Sahara African and Asian countries (Donfouet et al., 2019). Each year, immunization prevents over 2.5 million deaths among the under-fives from VPDs (Donfouet et al., 2019; Lakew et al., 2015). For this reason, vaccines are the most cost-effective public health interventions to reduce the high burden of the infectious diseases in Nigeria and other low-resource countries in sub-Sahara Africa and Asia (Gidado et al., 2014). Given the benefits of vaccines, most countries have been riding on the achievements of the EPI since its introduction in 1978 (Donfouet et al., 2019). Strengthening immunization will reduce the incidence of childhood diseases including tuberculosis, measles, poliomyelitis, diphtheria, and neonatal tetanus (Donfouet et al., 2019; Schlumberger et al., 2015). However, children can only benefit from the vaccines after completing all the required doses as per the recommended immunization schedule of the country (Schlumberger et al., 2015). The optimum uptake of all recommended vaccines as per the schedules is hardly achieved in children from the low socio-economic backgrounds, low-resource countries, and whose parents/caregivers have a low level of education (Donfouet et al., 2019; Lakew et al., 2015). There remains a significant variation in immunization coverage not only in different regions of the world but even within same countries as seen among the different zones and states in Nigeria (Gidado et al., 2014).

Childhood mortality from the low-resource sub-Sahara African countries accounts for over 41% of the estimated 10.8 million yearly global childhood mortality (Sowe &

Johansson, 2019; WHO, 2016). South Asian low-resource countries further account for over 34% of the annual global childhood mortality (Sowe & Johansson, 2019; WHO, 2016). Nigeria is among the six highly populated countries that constitute over a third of world's population, accounting for over 50% global childhood deaths (Antai, 2009). Nigeria has long ranked second and 17th in the global under-one and under-5 mortalities, respectively (Antai, 2009). Efforts have been made by different researchers to fully understand the factors associated with the poor immunization status of Nigeria and other low-resource countries (Antai, 2009; Gidado et al., 2015). The sub-optimum uptake of vaccines in Nigeria and other low resource countries are due to several challenges, including factors related to service-delivery like inadequate vaccines, logistics supplies, and cold chain system to maintain the potency of vaccines (Kimmel et al., 2007). Health service providers-related challenges include inadequate and inequitable distribution of the poorly remunerated health workforce, limited knowledge on effective vaccine delivery system, and frequent industrial actions leading to closures of health centers (Gidado et al., 2014; Kimmel et al., 2007; Ophori et al., 2014). Additionally, there are challenges related to parents/caregivers including lack of knowledge on the importance of accepting and completing immunization as per schedules, fear of side-effects, inconvenient timing in the clinics, long waiting times for vaccinations, difficulty in accessing the health center due to low economic power, and geographic distance (Ataguba et al., 2016; Ophori et al.; 2014). The low level of maternal education, low wealth index, higher birth order and sex of the child (female gender), religious affiliation, home delivery, young maternal age, and

lack of antenatal care attendance by the mothers are additional challenges associated with sub-optimum vaccine uptakes (Gidado et al., 2014; Lakew et al., 2014).

Recent studies examined the historical and political context of northern Nigeria, where some parents opposed vaccinations of their children due to lack of trust in government interventions (Murele et al., 2014). The hesitant parents have exercised fears of the western countries to reduce their predominantly Muslim populations through the administration of contaminated vaccines pushed to "sterilize" their children (Murele et al., 2014; Obadare, 2005). Likewise, Oluwadare (2009) argued that in Ekiti State, south-west Nigeria, some parents have a good knowledge of the benefits of vaccination but oppose vaccines due to ethnoreligious reasons. In Ethiopia, low maternal education and wealth index levels, lack of antenatal care attendance, and far distance to vaccination points contributed to inadequate immunization coverage of only 24.3% and high childhood mortality of 88 deaths per 1000 live births (Lakew et al., 2015).

Literature Search Strategy

The focus of this literature review chapter is to gain national and international insights into issues related to immunization uptake, most notably among children less than 5 years of age. As discussed by Yoon (2015), the variously reviewed literature served as the guiding principle and concepts of the research objectives, the problem statement, and the discussions. Additionally, examining the various literature increased the understanding of the scholarly account of published materials to gain further insights into the findings by other scholars and researchers to comprehend both what is known and what is unknown about immunization in different communities (Yoon, 2015).

Literature review involved searching databases including but not limited to ProQuest, MEDLINE, CINAHL PLUS, Pub Med, JAMA, Science index, SAGE journal online, Biomedical Central journals, and Nigerian government agencies' official websites. The keywords and terms searched included *immunization, routine immunization, immunization coverage, childhood vaccination, vaccines,* and *history of vaccines.* Additional search terms included *immunization schedule, immunization dropouts, fully and incompletely immunized children,* and so on.

The searches extended to international health organizational websites including those of the CDC, WHO, and the United Nations Children's Fund. I also searched Nigeria's National/State Primary Healthcare Development Agencies (NPHCDA/SPHCDA), Federal/State Ministries of Health (FMOH/SMOH), National Health Insurance Scheme, and other United Nations agencies including United Nations Development Program and United Nations Population Fund (UNFPA). I also searched book chapters on vaccines and VPDs for more insights on the history of vaccines and the progress made so far on achieving universal health coverage. The abstracts of those articles with limited access were retrieved due to the difficulty of getting permission to view their full details. Health websites of governments of the United States, Nigeria, and Britain were further explored, while reference lists of retrieved articles provided additional relevant information. Also searched were factors determining full childhood vaccination in Nigeria and other low resource countries in Africa and other parts of the world. To build the theoretical foundation for the study, I searched for peer-reviewed articles mostly published in the last 5 years.

Country Profile

Nigeria is the most populous country in Africa with an estimated population of about 200 million people in 2018 (projected from the last national census of 2006 at 2.6 percent annual growth rate; NPC & ICF Macro, 2018). Nigeria has a youthful population of children less than 15 years of age constituting over 44% and the median age between 18and 40 years, over 30% (NPCN & ICF Macro, 2018). For instance, in 2012 alone, close to seven million children were born, adding to this youthful population (NPCN & ICF Macro, 2018). While the country has a high annual birth rate, it also has a high infant and under-five mortality rates of 65 and 128 deaths per 1000 live births, respectively (Ataguba et al., 2016). About 40% of the under-five mortality is due to VPDs including measles, pneumonia, diphtheria, and other VPDs (Adeloye et al., 2017; Ataguba et al., 2016; Ibrahim et al., 2016). Over 46% of Nigeria's population lives in urban areas (Ibrahim et al., 2016). Nigeria has a total fertility rate per woman of 6.0 (WHO, 2015e). The country spends about 6% of its gross domestic product on health and a gross national income per capita of $5,360 (WHO, 2015e), life expectancy at birth of only 54 years, healthy life expectancy of 46 years, figures that are far lower than 58 and 50 respectively for the WHO region (WHO, 2015e). Between 2000 and 2012, Nigeria's life expectancy increased by 6 years, which is lower than the WHO regional average of seven years (WHO, 2015e).

Nigeria is a signatory to the declarations on the survival, protection, and development of children, articulated at the 49th World Health Assembly (WHA) in 1988 and reinforced by the world summit for children that took place in New York in 1990

(NPHCDA, 2009). Therefore, immunization in Nigeria is provided free without out-of-pocket charges in all public health facilities and some private and missionary health centers (Ataguba et al., 2016). However, the immunization coverage remains low, leading to increased morbidity and mortality from VPDs (Adeloye et al., 2017).

Nigeria has over 250 different ethnic groups speaking more than 500 different languages and dialects, with English being the official language (WHO, 2014c). Igbo, Hausa, and Yoruba are the three major local languages, while Islam and Christianity are the two dominant religious inclinations in the country (WHO, 2014c). In Sokoto and most of the states in the northern part of the country, Muslims predominate, as do Christians in the southern part of the country (Murele et al., 2014). The country has the second-largest economy in Africa currently with the main economic activities being export of oil and gas, financial services, and telecommunications (Murele et al., 2014; NPCN & ICF Macro, 2018). The World Bank estimates Nigeria's national poverty headcount ratio to be 46% (which is an estimate of the proportion of the population living below the national poverty line; Murele et al., 2014). Nigeria has a federal governance system with 36 states and the Federal Capital Territory, Abuja (NPCN & ICF Macro, 2018).

The states are further divided into 774 LGAs or districts and 9,565 political wards. There are six distinct geopolitical zones: the South-South, South-East, South-West, North-East, North-West, and North Central zones. The Federal Ministry of Health (FMoH) is responsible for setting health policies, managing all tertiary, and referral hospitals. The NPHCDA, a parastatal under the FMoH, is responsible for providing

technical support for planning, management, and implementation of all the components of primary health care (NPCN & ICF Macro, 2018). Therefore, NPHCDA procures all vaccines in collaboration with UNICEF for the vaccination against vaccine-preventable childhood diseases. All the primary health care facilities are under the jurisdiction of the local government councils (NPCN & ICF Macro, 2018).

Sokoto State Profile

Sokoto state is located in the north-west geopolitical zone of Nigeria, sharing a border with Niger and Benin Republics to the north and west respectively, and Zamfara and Kebbi states to the east and south-east respectively. The state has a landmass of 25,973 km2, laying between latitude 13°05′ N and longitude 05°16′E. The total population of Sokoto is estimated at 3.7 million people (projected from the 2006 national census; NPCN & ICF Macro, 2018). Most of the inhabitants of Sokoto are of Fulani ethnic nationality that practice Islam. Sokoto state shares similar cultural features, health-seeking behaviors, and health indices with neighboring states in the zone. In the last 3 years, Nigeria has experienced outbreaks of both VPDs like measles, polio, yellow fever, meningitis, and other highly infectious diseases like viral hemorrhagic fevers (Lassa fever; Ibrahim et al., 2016). Both the vaccine-preventable and other conditions have impacted Nigeria's key public health events and the vaccination program (Murele et al., 2014). Over the years, Nigeria has experienced immunization trajectories since the introduction of the EPI in 1979. For instance, Nigeria was removed from the list of polio-endemic countries in 2014 by the WHO due to remarkable progress made in the polio eradication initiative program. In 2016, two new cases of WPV were reported from

security compromised settlements in Monguno, Borno state as a manifestation of failure to sustain the progress made due to inadequate immunization quality (Adedokun et al., 2017). Ongoing armed insurgency and armed banditry in Nigeria has resulted in displacements and interruption of the provision of health care services like routine immunization with the attendant effect of more children not receiving all vaccines as scheduled (Vas et al., 2016). For instance, the Boko Haram insurgency in the North-Eastern part of the country mainly in Borno, Yobe, and Adamawa states has been ongoing for over a decade resulting in razing down of health centers, houses, and other private and public structures and displacement of millions of people including women and children (Vas et al., 2016). Sokoto and other states in the north-west zone of Nigeria have equally suffered from abductions for ransom, armed banditry, and razing down of health facilities (Vas et al., 2016). Due to insecurity, immunization and other services rendered by the primary healthcare centers have been disrupted. Insecurity has further placed a massive strain on the remaining few facilities with inadequate personnel (Vas et al., 2016).

History of Vaccines and Immunization

The practice of immunization dates back hundreds of years, starting with the prevention adopted by the Buddhist monks to drink snake venom to confer immunity to snakebite (Yaming et al., 2018). Vaccines function by stimulating the immune system of the body for protection against subsequent infection or disease (Yaming et al., 2018). The mechanism of action of vaccines is through the induction of the production of micro-organism-specific antibody (Jenner, 1798). Vaccines also induce both the B and T

memory cells to act synergistically in complex ways to protect the body against the pathogen (Yaming et al., 2018). Yaming et al. (2018) provided insights on how the Chinese employed “variolation” as a standard practice using cowpox as an antigen to confer immunity in the 17th century. At the same time, Edward Jenner founded vaccinology in 1796 after successfully inoculating a 13-year-old boy with vaccinia virus (cowpox) to produce life-long immunity to smallpox in the western world (Jenner, 1798). Between 1897 and 1904, Louis Pasteur developed the live attenuated cholera vaccine and inactivated anthrax vaccine in humans (Berche, 2012). Pasteur also developed the first rabies vaccine in 1885 (Berche, 2012). The success story of the smallpox vaccine and the mass immunization campaign resulted in the eradication of the highly infectious and deadly disease in 1979.

Immunization remains one of the most cost-effective public health interventions to reduce childhood morbidity, mortality, and disability (Hu et al., 2018; Sowe & Johansson, 2019). The WHO has reported that immunization prevents over two to three million deaths annually from VPDs including measles, tuberculosis, diphtheria, pertussis, tetanus, and a host of other childhood diseases (Sowe & Johansson, 2019; WHO, 2016). In Nigeria and other countries in the African region, the effectiveness of immunization was demonstrated in recent years with the remarkable reduction in morbidity and mortality from measles by about 90% between the year 2000 and 2009 (Adedokun et al., 2017). Additionally, the WHO in collaboration with Rotary International and other stakeholders launched in 1988 the GPEI following the significant progress made in interrupting the transmission of WPV in the Americans in the early 1980s and with

lessons learnt from smallpox eradication (Yehualashet et al., 2016). The number of polio cases drastically decreased by over 90% from over 350,000 cases annually from 125 countries in 1988 to only 21 cases in two endemic countries (Afghanistan and Pakistan) by the end of 2018 (WHO, 2019). However, despite the progress recorded since the introduction of vaccines into public health, the proportion of children completing the recommended vaccines as per each countries' immunization schedule has not changed significantly in the recent years, especially in Nigeria and other low resource countries (Ataguba et al., 2016; WHO, 2018). In 2017, while 116.2 million infants (about 85% of infants worldwide) received the three doses of diphtheria-tetanus-pertussis (DTP3 or pentavalent3) vaccine to protect them against infectious diseases and disability, over 19.9 million (15%) other children worldwide missed routine immunization services (WHO, 2018). Over 60 percent of these children live in Nigeria and nine other low-resource sub-Saharan African and Asian countries (WHO, 2018). With improved and sustained routine immunization coverage, an additional one and a half million deaths could be prevented every year (Ataguba et al., 2016; WHO, 2018).

The History of Immunization in Nigeria

In Nigeria, immunization program has been ongoing for over the last 50 years with good initial acceptance of all vaccines by all communities having been encouraged by the successful eradication of smallpox in the 1970s (Adedokun et al., 2017). WHO introduced the Expanded Program on Immunization (EPI) in 1974, targeting six vaccine-preventable diseases, including measles, tuberculosis, diphtheria, tetanus, poliomyelitis, and pertussis (Adedokun et al., 2017). The federal government of Nigeria launched the

EPI program in 1978 at the national level followed by all the states by 1982 (Adedokun et al., 2017; Machingaidze et al., 2015). Unfortunately, since 1988 after the launch of the global polio eradication initiative (GPEI), vaccine hesitancy began to manifest by some parents especially in the northern parts of the country (Adedokun et al., 2017). Also, shortage of vaccines became a severe challenge in the country within the same period with EPI almost collapsing in the country leading to very low immunization coverage to less than 10 percent (Adedokun et al., 2017). The childhood vaccination coverage remained low (around 20%) up to 1987 despite the relaunch of EPI in 1984 (Machingaidze et al., 2015).

In 1988, the government of Nigeria introduced the national immunization days (NIDs), leading to rapid progress and all-time high immunization coverage of about 80% by 1992 (Obiajunwa & Olaogun, 2018). The country failed to sustain the momentum made leading to another decline to less than 40% by 1999 forcing drastic measures by the government including increased funding to improve coverage to 80% by 2005 (Obiajunwa & Olaogun, 2018). Before then, the first nationwide rapid assessment of routine immunization (RI) coverage was conducted in all the six geo-political zones of the country in 2003. An action plan was developed, and additional funding made to accelerate immunization coverage in all the 774 districts from national and foreign governments and development partners including WHO, UNICEF, World Bank, USAID, DFID, and JICA (Machingaidze et al., 2015). Unfortunately, due to a couple of factors including professional and managerial incompetence, the achieved good immunization coverage could not be sustained leading to remarkable decline in childhood vaccination

coverage to as low as 12.7% in 2004 (Babalola, 2009). Within the same period, the polio eradication program was launched and received disproportionately high attention leading to diversion from sustaining the EPI program (Babalola, 2009). Obiajunwa and Olaogun (2018) reported that from the year 2000, quite a couple of Nigerian children failed to complete their immunization as per the standard schedule before their first birthdays. Worst still, findings from studies in several locations reported sub-optimum immunization coverage both in the rural and hard-to-reach settlements due to poor quality of services at the delivery points. Akutteh (2011) explained that the protective functions of the vaccines are lost when their prescribed regimen is not followed as seen in some rural areas with high incidences of childhood killer diseases. Jegede (2007) also identified other factors associated with the drastic fall in vaccination performance including religious and cultural reasons, lack of ownership at the district and community levels, weak awareness and mobilization, and lack of accountability and oversight functions.

Nigeria's routine childhood vaccination regimen still involves giving vaccines to protect children against the six-common vaccine-preventable diseases (National Population Commission (NPC) & ICF Macro, 2018). The vaccine-preventable conditions include tuberculosis, diphtheria, whooping cough (pertussis), tetanus, polio, and measles to reduce infant and child mortality (NPC & ICF Macro, 2018). The vaccines currently used during routine childhood vaccination are the DPT-Hep B-Hib or pentavalent vaccine for protection against diphtheria, whooping cough (pertussis), and tetanus (DPT), hepatitis B (Hep B), and Hemophilus influenza type b (Hib), tuberculosis, polio, and

measles (NPC & ICF Macro, 2018). The Pentavalent and pneumococcal conjugate vaccine (PCV) vaccines were introduced in phases into the routine childhood vaccination schedule in Nigeria in 2012 and 2014, respectively (NPC & ICF Macro, 2018). The PCV vaccine protects against streptococcus pneumonia bacteria that commonly causes pneumonia, meningitis, and other diseases in Nigeria (NPC & ICF Macro, 2018). In 2015, inactivated polio vaccine (IPV) administered at 14 weeks of life was introduced into the national routine childhood vaccination schedule (NPC & ICF Macro, 2018). However, the introduction of the IPV does not replace the long-used oral polio vaccine (OPV) but used to strengthen the immune system of the child against the deadly paralytic polio disease (NPC & ICF Macro, 2018).

Based on the guidelines of the WHO, Nigeria developed a schedule for the administration of routine childhood vaccines before the first birthday. A child is considered fully vaccinated after receiving a dose of Bacille Calmette-Guerin (BCG) vaccine against tuberculosis, three doses of DPT-Hep B-Hib or pentavalent vaccine for protection against diphtheria, whooping cough (pertussis), tetanus (DPT), hepatitis B (Hep B), and Hemophilus influenza type b (Hib), three doses of OPV against polio, and one dose of measles vaccine against measles disease (NPC & ICF Macro, 2018). The proportion of eligible children aged 12-23 months receiving all essential vaccines is an important yardstick to measure routine immunization coverage. A fully immunized child is one who is protected against vaccine-preventable childhood killer diseases responsible for the disproportionately high incidence of morbidity, mortality, and disability in the sub-Sahara African and Asian countries (NPC & ICF Macro, 2009). These vaccines

should be received before the first birthday, including BCG shortly after birth or during the first contact with the service provider (NPC & ICF Macro, 2009). Oral polio and pentavalent vaccines are given based on the immunization schedule at six, ten and 14 weeks of after birth while measles is at nine months of age (NPC & ICF Macro, 2009).

Nigeria's immunization schedule gives room for those children who missed to complete their routine vaccination during the first year of life to include 12-23 months and 24-35 months (NPC & ICF Macro, 2009 & 2018). This is the second critical measure of immunization coverage based on the age-appropriate vaccinations. In the same vein, a child aged 24-35 months is said to receive all age-appropriate vaccinations after collecting second measles dose at 18 months in addition to all age-appropriate vaccinations for 12-23 months old child (NPC & ICF Macro, 2018). In essence, Nigeria's routine immunization schedule gives room for a second chance to those children who missed to complete their routine immunization within the first year of life as per the schedule by second and third years of age (NPC & ICF Macro, 2018). Those children vaccinated after the first year of life could be used as the second critical measure of immunization coverage according to the age-appropriate vaccination (NPC & ICF Macro, 2018).

Nigeria's Childhood Vaccination Schedule

Vaccination schedule is a series of immunization that includes the timing of all the recommended doses depending on the country of residence. Larson, Cooper, Eskola, Katz, and Ratzan (2011) also described immunization schedule as a plan of action showing the various vaccines, doses, interval, age, and site of administration of each

antigen. The program ensures that a child receives all the recommended vaccine doses based on the appropriate age. Different countries of the world have their own vaccination schedules based on unique epidemiologic characteristics, including the type of infectious diseases and financial capabilities (Larson et al., 2011). However, the commonly recommended schedule by WHO include one dose each of BCG, hepatitis B, and oral polio vaccines at birth or within the first two weeks of delivery. At six, ten, and 14 weeks of age are three doses of oral polio, pentavalent and pneumococcal conjugate (PCV) vaccines. Also given at 14 weeks of age is inactivated polio vaccine (IPV) while Rotavirus vaccine is scheduled at 6 and 10 weeks but is yet to be introduced in Nigeria and most low-resourced countries. Finally, measles is scheduled at nine months while Human Papilloma vaccine is at nine years although also yet to be introduced in most developing countries. The WHO has further launched maternal and newborn tetanus elimination program but mostly as mass campaigns in Nigeria and other low-resource countries. Routinely, women of childbearing age between 15-44 years are scheduled to collect five doses of tetanus toxoid (TT) vaccine for life-long protection of mothers and their newborns. The five TT doses recommended by WHO are given as first two doses at one-month interval during the first pregnancy while the remaining three doses are given at every subsequent pregnancy or yearly intervals (Munoz, 2018).

Table 1: *Nigeria's New Childhood Vaccination Schedule*

Vaccine	**Age**	**Dose**	**Route of Administration**	**No. of Doses**	**Vaccination Site**
BCG	At birth or max 2 weeks after	0.05ml	Intradermal	1	Upper left arm
Oral Polio	At birth, at 6, 10 & 14 weeks of age	2 drops	Oral	4	Mouth
Pentavalent or Penta	At 6, 10 & 14 weeks of age	0.5ml	Intramuscular	3	Outer part of left thigh
PCV 10	At 6, 10 & 14 weeks of age	0.5ml	Intramuscular	3	Outer part of right thigh
Inactivated Polio Vaccine (IPV)	14 weeks	0.5ml	Intramuscular	1	Outer part of left thigh
****Rota	At 6 & 10 weeks	1ml	Oral	2	Mouth
Hepatitis B	At birth or max of 2 weeks after	0.5ml	Intramuscular	1	Outer part of right thigh
Measles	At 9 months of age	0.5ml	Subcutaneous	1	Upper left arm
Human Papilloma Virus (HPV)	At 9 years of age	0.5ml	Intramuscular	1	Deltoid

*HepB0 must be administered within the first 2 weeks after birth

**OPV0 must be administered within the first 2 weeks after birth

***Pneumococcal Conjugate Vaccine 9PCV) introduced in Q4 2014

****IPV was introduced in Q1 2015

****Rotavirus Vaccine is yet to be introduced

****Human Papilloma Virus Vaccine is yet to be introduced

Status of Childhood Vaccination in Nigeria according to the 2018 NDHS

The Demographic and Health Survey (DHS) is a nationally representative household survey conducted every five years to collect information on health and demographic coverage. In Nigeria, DHS was first held in 1990, followed by 1999 and subsequently, every five years in 2003, 2008, 2013, and 2018 (NPC & ICF Macro, 2018). So far, Nigeria has thus conducted six rounds of DHS with the result of the last exercise in 2018 showing that only 31% and 21% of children have received all essential and age-appropriate vaccinations respectively (NPC & ICF Macro, 2018). Only 50% and 47% of children less than one year of age received the third doses of pentavalent and polio vaccines, respectively (NPC & ICF Macro, 2018). Additionally, only 54% of under-one year children received measles which closely correlates with the widespread outbreaks reported in almost all states of Nigeria in 2019 due to low herd immunity (Nigeria Center for Disease Control (NCDC) reports, 2019). Information on immunization status is obtained during the 2018 demographic and health surveys from two ways, including either from the child-health vaccination card or recall history by the mother (NPC & ICF Macro, 2018). The result of 2018 NDHS revealed that urban children are likely to

complete all vaccinations as per schedules (44%) compared with only 23% by children in rural areas (NPC & ICF Macro, 2018).

Similarly, there is a regional variation in routine vaccination coverage among the six geopolitical zones with the lowest performance in the north-west. Only about 20% of children in the north-west, Nigeria have completed their immunization as per the schedule compared to their counterpart in the south-east with 57%. In Sokoto state, only 5% of children aged 12-23 months received all age-appropriate vaccinations compared to 87% in Anambra state in the south-east, Nigeria (NPC & ICF Macro, 2018). Across the country, it is established that vaccination improves with increasing maternal educational level and wealth (NPC & ICF Macro, 2018). The basic immunization coverage from the 2018 NDHS, differs slightly by residence where 44% of urban children received all basic vaccinations for age compared with 23% for rural children (NPC & ICF Macro, 2018). Children in the North West zone who scored only 20% on the average are less likely to receive all basic vaccinations than children in the South East (57%) with Sokoto scoring only five percent (NPC & ICF Macro, 2018).

The Factors affecting Childhood Vaccination in Nigeria

In both the low- and middle-income countries, the factors determining the uptake of vaccines have been widely studied (Sowe & Johansson, 2019). In most countries, similar factors influence both vaccination coverage and disparities (Ataguba et al., 2016). Sowe and Johansson (2019) reported that generally, demographic and socioeconomic factors, immunization services, and belief-related factors are associated vaccine uptake. Additionally, Antai (2009) argued that increased socioeconomic position increases the

likelihood of children being fully immunized (Antai, 2009). Attendance at antenatal care has a significant relationship between women that complete the recommended ANC visits and the immunization status of their children in Ethiopia (Sullivan et al., 2010). This may be an indication that a mother's contact with the healthcare system is extended to her child's healthcare (Sullivan et al., 210). It can be argued that ANC provides an avenue to engage women and perhaps even men in healthcare with an emphasis on immunization and follow up of young children. Similarly, hospital delivery was found to be associated with a higher likelihood of full vaccination (Antai, 2009). This association is expected given that skilled attendant at birth is one of the fundamental strategies under integrated maternal newborn and child health program of which childhood immunization is a component (Antai, 2009).

In the south-west part of Nigeria, Oladepo et al. (2019) identified several factors associated with lack of completion of routine immunization including fear of vaccine safety and side effects, previous negative experience with injections, and long-trekking distance to access services at the health centers. The long waiting time at the facility, personal or family lifestyles, and vaccine hesitancy for religious beliefs were additional factors (Oladepo et al., 2019). Even the poor attitudes and lack of adequate knowledge of the importance of immunization could also impede completion as per national schedule. Kiros and White (2014) reported that in a study to examine the impact of parental migration on vaccination of children, those born to migrant women were significantly less likely to get vaccinated fully compared to children born to non-migrant resident women (Kiros & White, 2014).

In Turkey, a similar finding was made from a study by Topuzoglu et al. (2015) that a significant difference in immunization status of children from migrant women with limited access to health centers who are disconnected from the social fabric of the host community. In Bangladesh, Sarker et al. (2019) reported the existence of disproportionate immunization coverage across socioeconomic and demographic factors that require an innovative approach for intervention programs to address the challenges. To achieve a better and wider benefits of immunization in Bangladesh, relevant policies that could favor low performing regions including close monitoring and evaluation of immunization coverage were introduced (Sarker et al., 2019).

The concerns on the safety of vaccines by parents and caregivers have featured prominently among the factors associated with low vaccine uptake and confidence on its protective role (Bugvi et al., 2014; Hardt et al., 2018). Because vaccine recipients are often healthy and young children, there is a lower level of tolerance for the risk of adverse events than with other medicines (Hardt et al., 2018). Adverse events to vaccination are mostly time-limited and mild, most commonly local reactions at the injection site (pain, swelling or redness), fever, and irritability (PAHO & WHO, 2002). Rare and severe adverse events to vaccination could occur, including convulsions and anaphylactic shock that are characterized by spontaneous remission with no sequelae (PAHO & WHO, 2002). However, fear of such adverse reactions can discourage parents/caregivers from having their children vaccinated. Misleading rumors about vaccine safety is a substantial barrier to immunization uptake globally (Bugvi et al., 2014; Hardt et al., 2018). Jegede (2007) observed that loss of public confidence in a

vaccine due to rumors of real or spurious adverse events could jeopardize well-planned immunization program, including public health campaigns leading to potentially disastrous consequences. In Nigeria, for instance, about a decade ago, there were rumors that the oral polio vaccine (OPV) being used for the global polio eradication initiative (GPEI) could lower the fertility of young girls (Jegede, 2007; Murele et al., 2015). This rumor spread across most northern states of Nigeria, resulting in the suspension of polio vaccination campaigns for almost a year (Jegede, 2007). The consequences of the suspension of immunization for that long was the explosion of more children being paralyzed by the polio disease in Nigeria and ultimately in 20 previously polio-free neighboring and far countries in Africa, Asia, and the Middle East (Jegede, 2007).

In the western world, a similar scientifically flawed, but widely publicized study, linking the measles-mumps-rubella (MMR) combination vaccine to autism fueled severe anxieties among parents/caregivers and questioned the safety of the vaccine (Wakefield, 1999). Within the same period, there was a decline in vaccine coverage in many countries with attendant outbreaks of childhood vaccine-preventable diseases (Wakefield, 1999). Consequently, measles outbreaks are making a comeback in several countries, including the industrialized countries like the United States, Austria, and the United Kingdom (CDC, 2014).

Service delivery factors associated with childhood vaccination include the proximity to the nearest health center (Kiros & White, 2004). In a study from rural Mozambique, distance and use of transport to get to the nearest health facility helped in the completion of routine immunization as per the recommended schedule (Jani et al.,

2008). Those households living closer and having affordable means of transportation to reach immunization service delivery points had the likelihood of their eligible children completing all doses as per schedule (Topuzoglu et al., 2005). It was also reported that systematic questioning about the vaccination status of every child attending a primary healthcare center for any reason improved vaccination coverage (Topuzoglu et al., 2005). A previous study from Mozambique identified missed opportunities for vaccination and poor understanding of contraindications by healthcare workers as significant deterrents of immunization coverage (Jani et al., 2008). Thus, exploiting all visits for curative care would be a cost-effective way of completely immunizing a child and increasing the overall immunization coverage (Jani et al., 2008). A strategy that focuses on integrating immunization activities with other services provided by the health system will go a long way in improving immunization coverage (WHO, UNICEF & World Bank, 2009).

Community participation in immunization programs have been documented to improve vaccine uptake and higher coverage which eventually reduced the incidence of vaccine-preventable diseases (Mbengue et al., 2017). Communities' participation and involvement could be in the area of planning, awareness creation, resource mobilization, and in regular monitoring and supervision (Itimi et al., 2012). Antai (2009) emphasized the need for greater community involvement in the conceptualization and implementation of vaccination programs. Jheeta and Newell (2008) demonstrated that strengthening advocacy, communication, and social mobilization activities at the community level is likely to improve participation in vaccination programs. Vaccination strategies are likely

to be more successful if they are based on an understanding of sociocultural norms and behavior of the people (Jheeta & Newell, 2008).

In the low-resource sub-Sahara African and Asian countries, there are serious underlying weaknesses in the entire health system which serve as the major obstacles to attainment of the universal immunization coverage (Adeloye et al., 2017; WHO, UNICEF & World Bank, 2009). In these countries, most health facilities have an inadequate and inequitable distribution of trained healthcare service providers. Health infrastructures and logistical support system are often overloaded, making the supply of vaccines and other related medical products very difficult. Inadequate funding is equally an essential barrier to the achievement of global immunization-related goals. The health systems in developing countries are faced with unreliable power supply resulting in inefficient refrigeration systems at health centers and clinics (PATH & WHO, 2009). The cold chain is therefore compromised due to lack of regular preventive maintenance. Additionally, there are insufficient medical supplies as added obstacles to service delivery, including the routine immunization program (Sullivan et al., 2010). An evidence-based strategy to address the burden of reduced completion rate of childhood immunization requires accurate knowledge of the underlying factors (Wiysonge et al., 2012). There is the need for interventions designed to improve childhood immunization to address individual, household, community, and societal factors that contribute to the problem (Wiysonge et al., 2012). While countries like Ethiopia are on their way to achieving a significant reduction in childhood mortality, additional efforts are required in

Nigeria to improve vaccination coverage, especially in the hard to reach populations to reduce childhood morbidity, death, and disability (Wiysonge et al., 2012).

Literature Review Related to Key Variables and/or Concepts

Socioeconomic Factors - Educational Level, Occupation, and Wealth Index

In studies of the population factors influencing vaccine uptake among eligible children, Kiros et al. (2010) argued that maternal and household characteristics including maternal education, occupation, and household wealth index are the most consistent predictors of childhood vaccination status. In different parts of the world, researchers have demonstrated that higher level of maternal education strongly predicts the likelihood of children being fully vaccinated (Forshaw et al., 2017; Assahun et al., 2015; Ataguba et al., 2016). Educated mothers are reported to have better access to health information and services and are eventually aware of benefits of vaccines and completing immunization according to the prescribed schedule (Ataguba et al., 2016 & Forshaw et al., 2017). Some authors have documented that female education improves child survival because of better knowledge of the accepting protective interventions including childhood immunization, exclusive breastfeeding, better nutrition, and so on (Streatfield et al., 1990). Kiro and Whyte (2004) argued that education is likely to improve responsiveness to new ideas and services, and more social confidence in dealing with health personnel. Additionally, knowledge may enhance the ability and willingness to cover distances in search of health services (Kiros & White, 2004). A report from Ghana asserted that the ability of a father to speak English was significantly associated with higher childhood vaccination (Brugha

et al., 1996). A similar study from Ethiopia observed that paternal factors including age, education, and wealth are likely to influence the completion of vaccination according to the schedule (Sullivan et al., 2010). In Turkey, it was reported that children from families with higher socioeconomic status have a higher chance of being fully vaccinated (Topuzoglu et al., 2005). Mothers' education level and employment status were found to determine the completion of the vaccination series (Topuzoglu et al., 2005). Bugvi et al. (2014) demonstrated how children of manual workers were at higher risk of incomplete immunization than the children of relatively better-off professionals. The aforementioned underscores the importance of broader social context in accounting for variations in child welfare, including vaccination patterns.

Globally, scholars have established correlation between maternal education and reduction in childhood mortality through acceptance of many interventions (Forshaw et al., 2017). Oleribe et al. (2017) also documented that several factors determine the uptake of vaccines at different stages of commencement, continuation and completion of the immunization as per Nigeria's recommended schedule. In Kenya, maternal educational level significantly influences immunization coverage because with higher level of education, mothers are more aware of the importance of immunization (Maina et al., 2013). Gidado et al. (2014) documented that in Zamfara state, Nigeria, maternal education is correlated with completion of immunization as per the schedule. Ozer et al. (2018) reported that maternal education significantly improves the take-up of the last doses of Hepatitis B and DPT immunizations in Turkey. Forshaw et al. (2017) reviewed 37 papers and reported an increasing childhood immunization uptake with increasing

maternal education. The odds of full childhood vaccination are 2.3. times greater in children whose mothers received secondary or higher education compared to children whose mothers had no education. Therefore, improving maternal education also increases childhood vaccine uptake and coverage. In Nigeria, NDHS 2018 report shows that across the country, vaccination improves with increasing maternal educational level and wealth index (NPC & ICF Macro, 2018).

In a study on maternal characteristics and childhood vaccination in north central part of Nigeria, the occupation of a child's parents especially that of the mother is an additional factor influencing the uptake of vaccines (Adenike et al. 2017). Adenike et al. (2017) reported that although majority of both rural and urban respondents were housewives, those employed had significantly higher likelihood of their children being fully vaccinated. Antai (2009) further supported the finding that employed and working mothers are likely to vaccinate their children compared to unemployed full-time housewives. Additionally, Obembe et al. (2019) reported that there is a significant association between household wealth and childhood immunization status in Nigeria. Gram et al. (2019) also reported that being rich is associated with the likelihood of completion of immunization even in the core-North Nigeria with established existence of health disparities due to low wealth status of most of the citizens. The prevalence of complete immunization was found to be considerably higher among children of the rich compared to the poor (Gram et al., 2019).

Employment and wealth status are other factors influencing immunization of children. Children from richer families are more likely to receive immunization compared

with those from poorer homes (Assahun et al., 2015). Antai (2009) also observed that household wealth and mothers' occupation influence vaccination uptake in Nigeria. Fatiregun and Okoro (2012) demonstrated that fully occupied and working mothers have been shown to accept vaccination for their children much more than non-working mothers especially in countries where immunization and other health services depend on health insurance that is tied to employment.

Ethnoreligious Affiliation - Religious Beliefs and Tribe/Ethnicity

Religion is known to influence decisions of parents/guardians towards immunization among the orthodox Protestant minority group in The Netherlands (Ruijs et al., 2013). Ruijs et al. (2013) argued that parents/guardians oppose vaccination of their eligible children for religious reasons in The Netherlands. In India, Shrivastwa et al. (2015) found religion as one of the factors determining childhood vaccination with Muslim children having greater chance of being under-vaccinated compared to the Hindus. In Nigeria, Antai (2009) analyzed 2003 demographic and health survey data to determine the role of religion in childhood vaccination and reported a significantly higher proportion of poorly immunized children among mothers who identified their religious affiliation as Muslims. Partially or non-immunized children were more likely to be from Muslim mothers compared to children whose mothers identified themselves as Christians (Antai, 2009). Babalola (2011) reported that vaccine hesitancy amongst mothers in Northern Nigeria were related to their religious beliefs based on the rumors that vaccination contradicted the practices of the Islamic faith.

In Nigeria, a significant association between ethnicity and completion of immunization was identified where children of Igbo mothers have 1.3 times the chance of receiving full immunization compared with children of mothers from the Hausa/Fulani/Kanuri ethnic groups (Antai, 2011). The ethnic difference is a reflection of differences in social identity, attitudes and health-seeking behavior and disparities in socioeconomic position (Antai, 2009). The children of the Ibos who have high economic power are twice as likely to be fully immunized compared to the children of the Hausas who have low economic potential (Ataguba et al., 2016).

Place of Residence - Rural and Urban

In most countries, there are bigger urban populations than rural populations due to rural-to-urban migration. In the same way, urban–rural differentials are manifested in access to healthcare interventions including childhood immunization with more utilization in urban than in the rural areas (Oleribe et al., 2017). In Nigeria, immunization coverage differs slightly by residence from the 2018 health survey where 44% of children in urban communities being fully vaccinated compared to only 23% in rural areas (NPC & ICF Macro, 2018). Children in the North West zone who scored only 20% on the average are less likely to receive all basic vaccinations than children in the South East (57%) with Sokoto scoring only five percent (NPC & ICF Macro, 2018). Additionally, states in the southern part of Nigeria were found to be significantly related to better vaccination rates compared to the northern states (Adedokun et al., 2017; Oleribe et al., 2017)

Children's Biological Characteristics - Sex and Birth Order

Child's biological characteristics including being a male child and being first or second born in a family significantly increases the chance of being vaccinated (Kitamura et al. (2013). Immunization uptake may also vary by sex of the child where male children are more likely than females to receive complete doses of vaccines (Kiros & White, 2004). Antai (2009) demonstrated that the pattern of full immunization clusters varies by sex of children within families as well as within communities. Male children living within the same community tend to have been fully immunized compared to female children (Antai, 2009).

Antai (2011) documented that children in Nigeria of the fifth and above birth order after short birth interval of 24 months or less have significantly lower likelihood of being fully vaccinated compared to those of second to fourth birth orders.

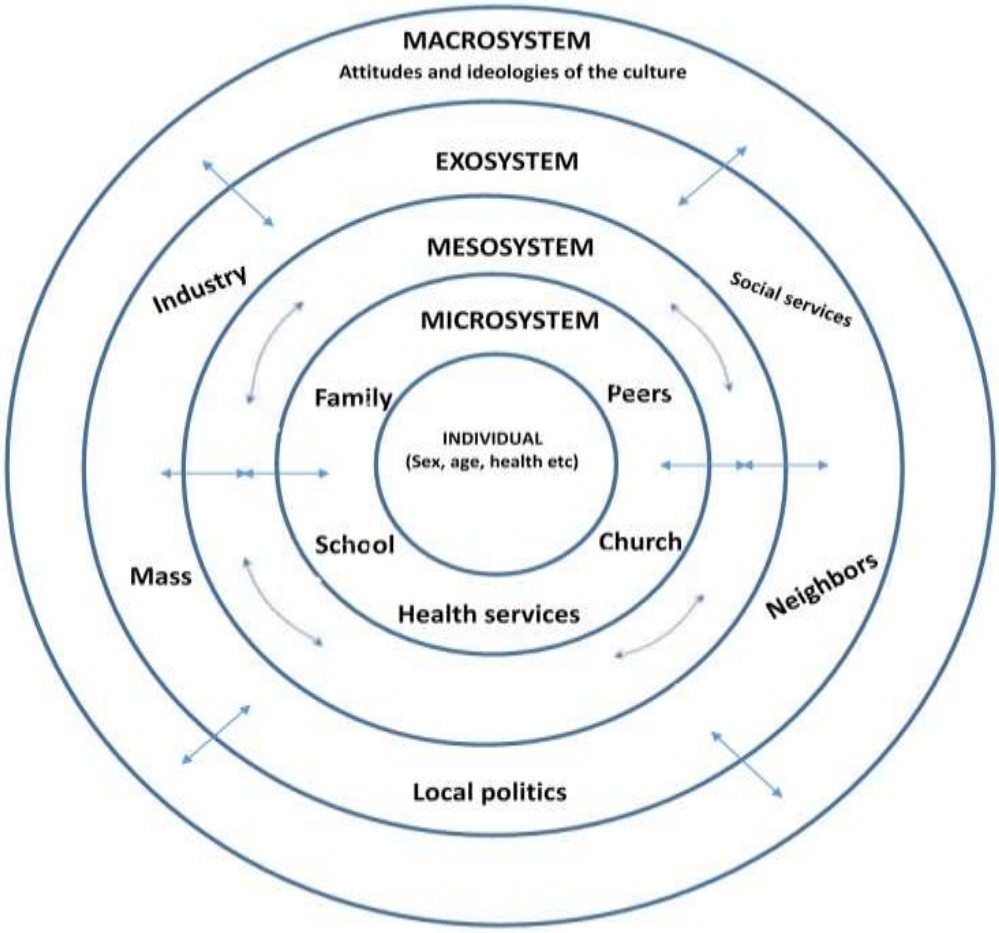
Theoretical Framework

The Social Ecological Model (SEM)

The Social Ecological Model (SEM), provides the foundation of inquiry into the multiple levels of influence that shape and are shaped by the social environment (Bronfenbrenner, 1977). Urie Bronfenbrenner's ecological systems theory is used as the theoretical framework to study how sociodemographic factors influence a child's life and behavior including getting vaccinated, going to school, and so on. Bronfenbrenner (1977; 1979) developed the adaptation called the Ecological Systems Theory (EST) to provide insight into how the development and growth of a child depends on factors innate to the child and his/her environment. Being grounded in social and cognitive psychology, the

EST holds that the health and developmental outcomes of children are influenced by various ecological systems (Bronfenbrenner, 1977). The SEM provides an

Figure 1. Bronfenbrenner's Illustration of Social Ecological Model



Adopted from Mash (2019). *Abnormal child psychology*. Wolfe, David A. (David Allen), 1951- (Seventh ed.).

understanding of how the behavior of an individual is integrated in a dynamic network of intrapersonal or inherent characteristics, interpersonal relationships, institutional factors, community factors, and public policy. The model assumes that there is a reciprocal interaction between individuals and their environment. By implication, environment

influences an individual just as the individual also influences his/her environment. The model further assumes that the environment is comprised of several overlapping levels.

Bronfenbrenner's ecological model described the contexts of development into five levels of external influence. These levels are categorized from the most intimate level to the broadest. An individual's intrapersonal, interpersonal, organizational, and the community are the four-level interrelated social ecology model shaping health behaviors and outcomes (CDC, 2007). The EST holds that humans encounter different environments throughout their lifespan which could have an impact on their behaviors in varying degrees. The EST has five ecological systems including the microsystem, the mesosystem, the exosystem, the macrosystem, and the chronosystem. These five systems play critical roles in shaping the psychological development of children (Darling, 2007; Hong & Eamon, 2012).

The Microsystem (The Intrapersonal Characteristics)

The microsystem as defined by the Bronfenbrenner theory is the smallest and most immediate environment in which an individual lives (Salihu et al., 2015). The microsystem is the closest layer to an individual because it has the inner structures with which to directly interact with. The microsystem, being the immediate surroundings, is the closest to the individual and has the strongest influences (Salihu et al., 2015). For a child, the microsystem therefore, comprises the child's daily home, school, and peer group which will affect growth and development. Interactions within the microsystem typically involve personal relationships with family members, classmates, teachers and caregivers.

The Mesosytem (The Interpersonal Relationships)

The mesosystem is the second circle that looks beyond immediate interactions. The meosystem includes those the individual has direct contact with including school, work, place of worship, and neighborhood. The mesosystem serves as the layer providing the needed connection between the various structures of an individual's microsystem (Berk, 2000). For serving as the link between the individual's microsystem and other systems, the mesosystem closely interacts or connects with each other like the parents, school, and so on (Darling, 2007; Hong & Eamon, 2012).

The Exosystem (The Institutional Factors) Organizational

The external environment with no direct bearing on the child is the exosystem including parent's workplace or schedules which affects the child (Bronfenbrenner, 1997; CDC, 2015). Although the exosystem does not directly impact the individual, it exerts both negative and positive interactive forces on the individual such as community features and social networks. For instance, refusal to promote a parent when due at a place of work may lead to unnecessary anger at home including child abuse.

The Macrosystem (The Community Factors)

The macrosystem setting is considered as the outermost layer in the child's environment including cultural values and broader social attributes (Bronfenbrenner, 1977). The macrosystem is the largest and most distant collection of people and places to an individual or a child that still have significant influences on him/her. The macrosystem setting is the cultural contexts of an individual involving the sociodemographic characteristics of an individual and/or his family, ethnicity or religion. This ecological

system is composed of the children's cultural patterns and values, specifically their dominant beliefs and ideas, as well as political and economic systems. For instance, children in war-torn zones are likely to experience a different kind of development compared to children in peaceful environments.

The Chronosystem (The Public Policy)

The chronosystem contains both internal and external elements of time and historical content; in revised models, this level includes the influence of the public policy (Salihu et al., 2015). The chronosystem consists of all of the experiences that an individual had interactions with during his/her lifetime, including environmental events, major life transitions, and historical events as influenced by cultural norms and policies in health, economy, and education (Salihu et al., 2015).

At the various levels within the SEM model, positive or negative contributions to the child can result. Within the context of strengthening immunization services in Sokoto state, and other states in Nigeria, all the layers of the environment of the child could influence completion or lack of completion of childhood vaccination. The five systems of the model usually offer positive or negative influence on behaviors.

Operationalization of the SEM to the Study

The individual's immediate surroundings and biological factors including the family, neighborhood, or school, sex and age respectively is influenced by other closer layers of interconnected structures (Berk, 2000). The five systems of the SEM could positively or negatively influence behaviors at various levels within the model. Within the context of strengthening immunization services in Sokoto state, and other states in

Nigeria, all the layers of the child‘s environment could influence completion or lack of completion of childhood vaccination. In this study, the key independent variables are mapped to the different levels within the SEM including:

a) INDIVIDUAL: Sex, Birth Order

b) RELATIONSHIP: Religion, Cultural affiliation

c) COMMUNITY: Place of Residence, and

d) SOCIETAL: Religion, Residence.

Using the SEM, it is pertinent to recognize how childhood vaccination is perceived by the various cadres of people or the population in Sokoto state, Nigeria. All layers of children’s environment do influence access to services including education, vaccination, and so on. In line with SEM, the individual, relationship, community, and societal factors are all related to the completion of childhood vaccination in Nigeria (CDC, 2015). Murele et al. (2014) documented how relationships between cultural, religious, and environmental factors influence parents’ acceptance or refusal of vaccines for their children. Improving the education of parents could enhance better habits and health seeking behavior, and improve interaction with the health community In Sokoto and other states in the north for instance, cultural and environmental factors have influenced some parents to refuse vaccines for their children leading to low immunization coverage and herd immunity with attendant effect of frequent outbreaks of vaccine-preventable diseases including measles, tuberculosis, hepatitis, tetanus, and poliomyelitis (Murele et al., 2014).

Summary and Conclusions of Chapter 2

In Chapter 2, I explained how the literature search strategies were done in various databases using different search engines and related search terms. Most of the literatures searched were within the range of five years (2014-2019). However, in some areas suffering from paucity of data, the search extended beyond five years to even ten years and above. I searched the current literature on the health belief model as the conceptual framework that guides the dissertation. The health belief model as a theoretical framework is useful in understanding the factors associated with health-promoting and healthcare-seeking behavior, including acceptance of preventive interventions like an immunization against vaccine-preventable diseases.

The literature review chapter covers several factors influencing parents'/caregivers' decisions on whether to protect their children through vaccination or not, including educational level, wealth index, age, birth order and sex of the child, religious inclination, and so on. From the review, it is clear that many studies have been carried out globally, including in Nigeria on the subject matter. However, the studies done were not localized but are nationwide or involving many countries, or at best in some zones without taking into considerations the peculiarities of the cultures and healthcare-seeking behavior of local communities. When a particular community suffers from a persistent problem or challenges, then there is the need to take a deep dive to comprehend better the local context to proffer a lasting solution as seen in Sokoto for over a decade. The studies conducted in Nigeria were mostly done in the southern part of the country with different sociocultural, socioeconomic, and religious backgrounds from

a core northern state like Sokoto, which is the focus of this study. As a result, there is the challenge of the lack of external validity to apply to some northern states. Similarly, some studies done in the northern part of Nigeria have limited sample size to qualify for external validity. However, this dissertation will use secondary data from the latest survey in Nigeria, the 2018 demographic and health survey (NDHS). NDHS data are a result of a country-wide survey that is representative of each zone for the required external validity and to be able to generalize the findings (NPCN & ICF, 2018). This study intends to fill the gaps and add to the body of existing literature as well as key stakeholders and policymakers to address the challenges of low vaccine uptake and immunization coverage. Completion of routine immunization as per the recommended schedule of the country will improve the proportion of fully protected children and herd immunity strong enough to reduce the under-five morbidity and mortality in Sokoto and other states in the northern parts of Nigeria.

In the second chapter of this dissertation, I examined the literature and population structure of Nigeria as a country and Sokoto state as a case study. The next chapter will cover the research methodology, including sampling technique and analysis of data. It is critical to identify and address knowledge gaps and discuss ethical considerations and present a description of the variables in the study, as well as potential threats to validity.

Chapter 3: Research Method

The purpose of this study is to use the dataset from 2018 NDHS to determine the association between parental socioeconomic, ethnoreligious, and immunization services-related factors and children's biological characteristics and completion of childhood vaccination in Sokoto state, Nigeria. The report and dataset of the NDHS 2018 were released in 2019 by the NPC, Nigeria, as the sixth demographic and health survey carried out in the country. Previously, Nigeria conducted NDHS in 1990, 1999, 2003, 2008, and 2013 (NPCN & ICF, 2018). The study is a cross-sectional design aimed at addressing the challenges of persistently low immunization coverage in Sokoto state. This chapter contains a detailed explanation of the research methodology which includes research design, source of data collection, sampling size, sample design, sampling procedure, inclusion criteria, questionnaires, research questions, and hypotheses. Also, it contains the EDA, descriptive, inferential statistics, scope, and limitation of the study.

Research Design and Rationale

Research designs are generally outlined describing how researchers answer the formulated research problem (Blaikie, 2003). The purpose of a research design is to organize and execute the activity concerned to maximize how valid the findings are (Blaikie, 2003). In this study, I used a cross-sectional research method because it entails using collected data for analysis to arrive at a logical conclusion by comparing the pattern of association or relationship between the variables (Johnson & Christensen, 2000). The data used for this study were collected during the 2018 NDHS. Thus, this study is

quantitative because I wanted to determine the association between the dependent and independent variables.

Methodology

Types and Sources of Data

The 2018 NDHS was conducted mainly to provide the data that could be used to monitor Nigeria's population and health situations. Since 1990, Nigeria has been conducting NDHS, with the one in 2018 being the sixth in the series (NPCN & ICF Macro, 2018). NDHS 2018, like all other DHS, is a cross-sectional survey conducted to provide data on critical indicators for use by the population at various levels nationally and even internationally (NPCN & ICF Macro, 2018). Globally, the demographic and health surveys have several objectives, including the provision of reliable estimates of data for family planning, estimation of countries' fertility levels, for assessment of the nutritional status of women in the childbearing ages and their young children, and so on (NPCN & ICF Macro, 2018). NDHS provides information on the demographic and health indicators of countries. Amongst several outcomes, the 2018 NDHS provided data on the immunization status of the target population of children aged 12-23 in Sokoto state as 148,000. Additional information provided in the 2018 survey was immunization status of children aged 24-59 months and information on the status of maternal and child health including HIV/AIDS behavior (NPCN & ICF Macro, 2018). Records are also available on the disease burden of sexually transmitted infections, domestic violence, the odd practice of female genital mutilation or cutting which is still prevalent in Nigeria and other low resource countries, and so on (NPCN & ICF Macro, 2018). To gain access to

the NDHS data, after obtaining IRB approval from the Walden University, I applied for permission from ORC Macro and ICF International, the custodians of the data, to get the raw data from MEASURES DHS+.

Sample Design

The sampling frame used for the 2018 NDHS is the national population and housing census (NPHC) of the federal republic of Nigeria, which was conducted in 2006 by the NPC. Nigeria is sub-divided into states administratively with each state further divided into 774 districts or LGAs. Each LGA is divided into wards or localities as the lowest administrative structure in the country. In addition to these administrative units, during the 2006 NPHC, each locality was subdivided into convenient areas called census enumeration areas (EAs). The primary sampling unit, referred to as a cluster for the 2018 NDHS, is defined based on the EAs from the 2006 EA census frame. Although the 2006 NPHC did not provide the number of households and population for each EA, population estimates were published for more than 800 LGA units. A combination of information from cartographic material demarcating each EA and the LGA population estimates from the census was used to identify the list of EAs, estimate the number of households, and distinguish EAs as urban or rural for the survey sample frame. Before sample selection, all localities were classified separately into urban and rural areas based on a predetermined minimum number. Any locality with more than a minimum population size of 20,000 was classified as urban. In the 2018 NDHS, the sample size was estimated based on a two-stage cluster design with the EAs as the sampling units for the first stage. This was followed by listing of all households in each of the 1,400 selected EAs across

the country. Thirty households were selected randomly from each of the 1,400 EAs to give total sample size of 42,000 households (NPCN & ICF Macro, 2018). However, using equal probability systematic sampling, 41,668 households were selected during the field work, but 40,666 households were occupied. From the occupied households, 42,121 women aged 15-49 were identified and interviewed with 41,821 (99% response rate) women providing answers to the questionnaires. In Sokoto and the other 36 states, a minimum target of 1,128 women completed the interviews (NPCN & ICF Macro, 2018).

Inclusion and Exclusion Criteria

The 2018 NDHS included all women aged 15-49 in the sample households. Those who were either permanent residents of the selected households or visitors who stayed in the households the night before the survey were eligible to be interviewed. The men's survey was conducted in one-third of the sample households, and all men aged 15-59 in these households were included. In this sub-sample, one eligible woman in each household was randomly selected to be asked additional questions about domestic violence. Similarly, biomarker information was collected only in those households selected for the men's survey. The biomarkers included in this survey were height and weight for women aged 15-49 and children aged 0-59 months, hemoglobin testing for women aged 15-49 and children aged 6-59 months, and testing for malaria and sickle cell disease among children aged 6-59 months. The disability module, female genital cutting module, and fistula module were implemented in the two-thirds of the households that were not selected for the men's survey. The survey was successfully carried out in 1,389 clusters after 11 clusters with deteriorating security situations during fieldwork were

dropped in some states including Sokoto (3 clusters), Zamfara (4 clusters), Lagos (1 cluster), Katsina (2 clusters), and Borno (1 cluster).

Some women and men were excluded from the 2018 NDHS including both women and men below the age of 15. Also excluded were women and men above the age of 49 and 59 respectively. Both women and men who were neither permanent residents of the selected households nor visitors who did not stay in the household the night before the survey were not eligible to be interviewed. Participants who declined consent to participate in the study were also excluded. Additionally, the survey interviewers excluded and did not interview women in households that were not pre-selected. To prevent bias during the implementation, no replacements of the pre-selected households were allowed.

Recruitment of Participants

The 2018 NDHS exercise was conducted across all the 37 states of the country; hence, it was a nationally representative study involving the entire resident population. The EA list was derived from the country's last national census held in 2006, which was used as the sampling frame for the 2018 DHS. Enumerators for the survey were people who had field experience from previous NDHS and were recruited by the technical team of the NPC. All field staff was recruited through very competitive methods of written examination followed by oral interviews by experienced personnel focusing on the major languages in the country. The educational qualifications required for being a field staff for the 2018 NDHS was a minimum of the national diploma or national certificate of education but preferably university graduates. Additionally, the recruited field staff was

represented from all the 37 states of the country. All the field staff was trained in the classroom on how to use the Biomarker Checklist followed by 2-3 days of field practice between July and August 2018. The training was conducted by ICF staff with emphasis on the technical components of the survey, biomarkers, and the CAPI data collection system. The training focused on key components of the survey, interview techniques and procedures for completing the NDHS questionnaires, and administration of interviews using the CAPI system.

Sample Size

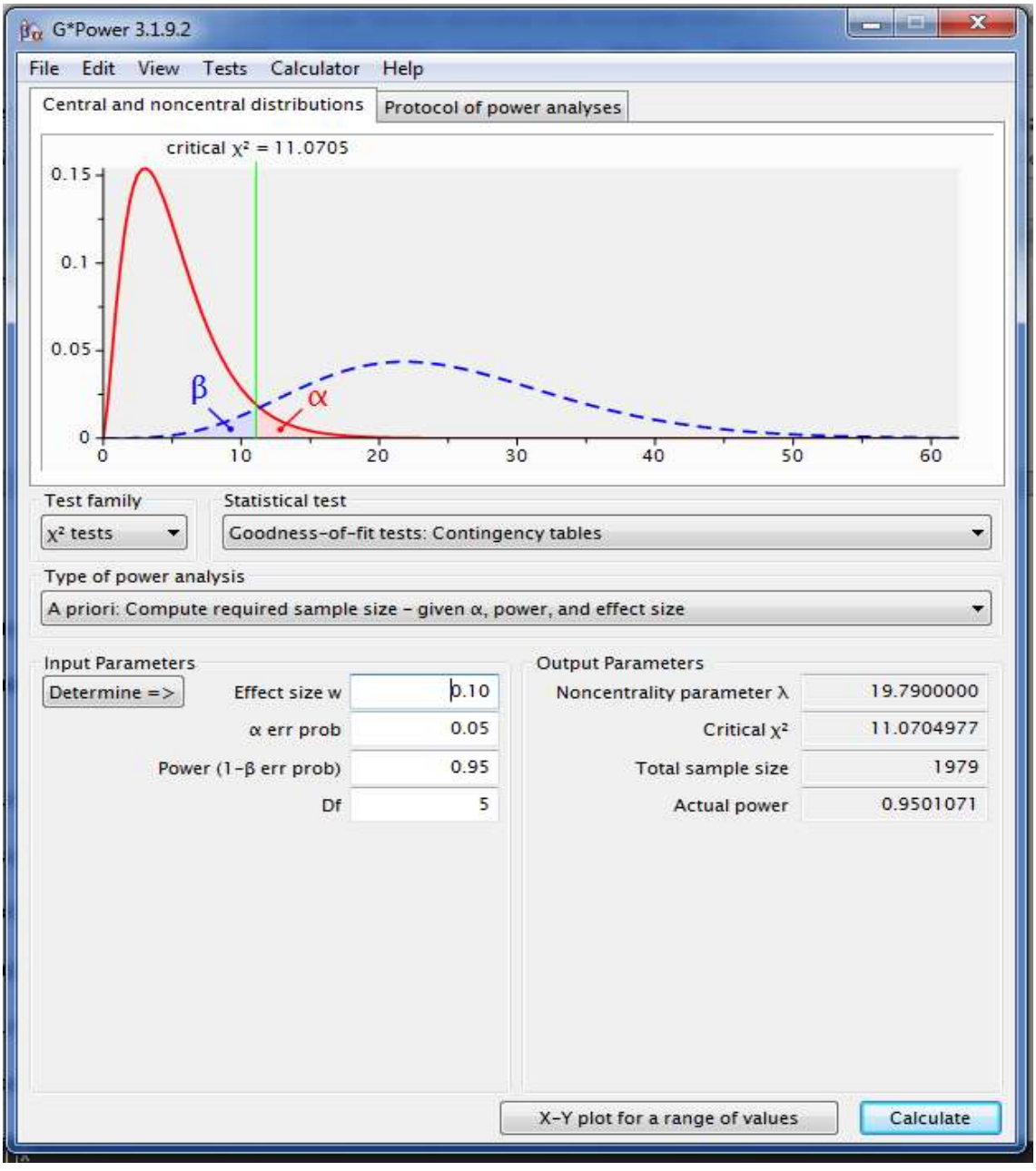
The quality of research does not only depend on the appropriateness of the methodology and instrumentation but also the suitability of the sampling strategy used (Blaikie, 2003) and the size of the sample. The sample size is defined as the number of observations used for calculating estimates of a given population (Blaikie, 2003). The sample size is determined to reduce expenses and time by allowing researchers to estimate information about a whole population without having to survey each member of the population. The larger the sample size, the more accurate the results will be (Julious, 2004).

The determination of sample size is usually guided by considering certain criteria, including the type of statistics to be used in answering the objectives of the study, the margin of error, power value, effect size, and nature of data to be collected (Cohen, 1988). These issues are considered so that the sample could represent the population characteristics. In answering the research questions and the objectives of this study, the inferential analysis was used. The sample size of the study was estimated for both the chi-

square and logistics regression analyses using the G*Power Analysis Software 3.1.9.2 (Faul et al., 2007). Using the G*Power analysis software, the sample size of 1,979 was calculated for the Chi-Square ($\chi 2$) statistics and 1,727 for the logistic regression analysis at alpha (α) = 0.05 (two-tailed) significant level, effect size at 0.10 and 0.95 power value. Therefore, in this study, the sample size is 1,979 for the Chi-Square and 1,727 for logistic regression, as seen in Figures 2 and 3 below.

Figure 2

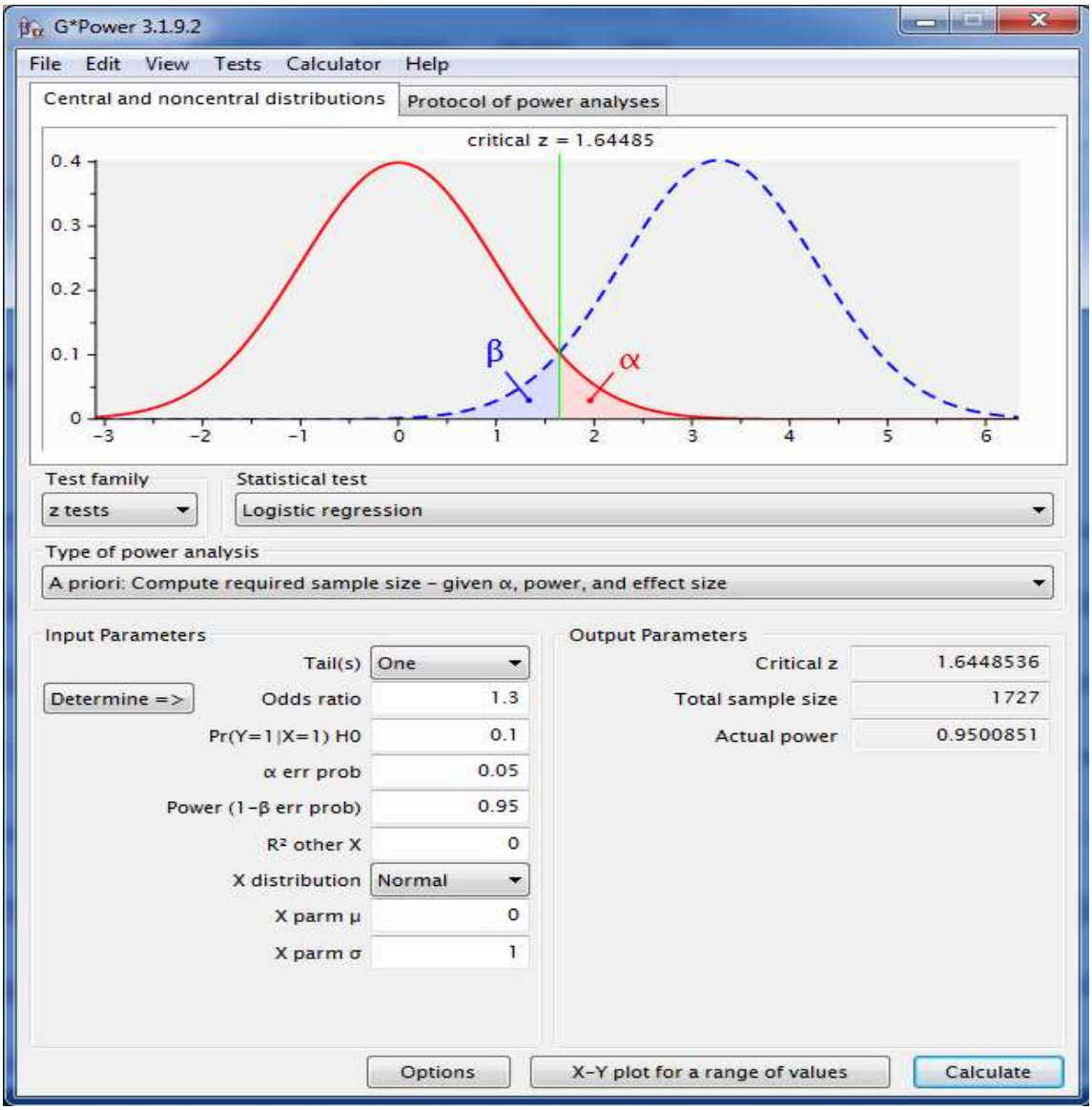
*Sample Size Determined for Chi-Square Statistics Using G*Power Analysis Software 3.1.9.2*



*Source: (*Faul et al., 2017)

Figure 3

*Determining the Sample Size for Logistic Regression Analysis Using G*Power Analysis Software 3.1.9.2*



*Source: (*Faul et al., 2017)

Israel (1992) suggested that increasing the estimated sample size by 10-30% in case of contingency that may occur during the data collection process. Similarly, Salkind (2012) suggested oversampling by 40-50% to avoid sampling error. In this regard, the researcher, based on empirical justification, accepted to increase the estimated sample sizes by 25% in order to address any kind of errors and/or other inconsistencies that may occur during the data collection process. The estimated sample size for the Chi-Square is 1,979 and for logistic regression 1,727.

Therefore, the actual sample size for the chi square is 2,474 i.e. 1979 + 495 $\left(\frac{25}{100} \times 1979 = 495\right)$, while the actual sample size for the logistic regression is 2,159 i.e. 1727 + 432 $\left(\frac{25}{100} \times 1727 = 432\right)$. Since the larger the sample size of a study, the better the effect size and level of significance (alpha value), 2,474 is the sample size for the study because it is adequate for both Chi-Square and Logistic Regression analysis. During data analysis stage, Sokoto state had 1,919 cases in the 2018 NDHS dataset. When the 1,919 cases were keyed into SPSS, the entire columns for 36 cases were missing in the data set. This necessitated the removal of those 36 cases thereby reducing the sample size to 1,883 (1, 919 – 36 = 1, 883) for the data analysis as suggested by Pallant (2011) and Field (2013).

Study Population

The present study intends to use secondary data from the 2018 NDHS where the sample size was estimated using a stratified, two-stage cluster design with the enumeration areas (EAs) as the sampling units for the first stage. The second stage was a

complete listing of households in each of the 1,400 selected EAs. From the 1,400 EA clusters, a fixed number of 30 households was selected in each cluster resulting in an estimated sample size of 42,000 households (NPCN & ICF Macro, 2018). During the fieldwork, 41,668 households were selected using equal probability systematic sampling, out of which 40,666 households were occupied. From the occupied 40,666 households, 42,121 identified individual women age 15-49 were interviewed. From the 42,121 women interviewed, 41,821 women completed the interview, yielding a response rate of 99%. In each of the 37 states, a minimum target of 1,128 women completed the interviews (NPCN & ICF Macro, 2018).

All the selected respondents who were either permanent residents of the selected households or visitors who stayed in the household the night before the survey were eligible and were interviewed. Using the Woman's Questionnaire, information was collected from all eligible women age 15-49 on their background characteristics (including age and education), birth history and child mortality, antenatal delivery, and postnatal care, and vaccinations and childhood illnesses, and fertility preferences (including desire for male children). In addition, the sample size used in the 2018 NDHS was larger than the ones used in the five previous surveys, covering a total of 1,400 clusters across the country. Social and behavior change communication questions on malaria, minimum dietary diversity among women, fistula, domestic violence, disability, and a host of others were included as requested by various stakeholders.

Sampling Procedure

The stratified sampling procedure was used for the 2018 NDHS and samples selected in two stages. Stratification was done by separating each of the 37 states into urban and rural areas to give a total of 74 sampling strata. In each stratum, samples were selected independently through a two-stage selection process. To achieve implicit stratifications at each of the lower administrative levels, the sampling frame was sorted out using a probability proportional to size selection during the first sampling stage before sample selection according to the administrative order. The household numbering was done using tablets followed by a random selection of households through computer programming. During the interviews, the survey interviewers applied the checklists to only the pre-selected households without the option of replacing or changing the pre-selected households to prevent bias in the implementing stages. Due to the non-proportional allocation of the sample to the different states and the possible differences in response rates, sampling weights were calculated, added to the data file, and applied so that the results would be represented at the national level as well as the domain level. Because the 2018 NDHS sample was a two-stage stratified cluster sample selected from the sampling frame, sampling weights were calculated based on sampling probabilities separately for each sampling stage and for each cluster. For this study, the target sample will be selected from the original secondary dataset of the 2018 NDHS by using the "select cases option in the SPSS" i.e. from the 2018 NDHS manuals where the data was collected based on regions and states. From the original dataset, a researcher could easily select the required dataset of each state or region.

Data Collection Technique

The secondary data used for the study were collected during the 2018 Nigeria Demographic & Health Survey using Questionnaires as the data collection instrument. The recruiting techniques involved dividing the country into 37 states and each state subdivided into LGAs and LGAs into localities. Each locality was subdivided into census enumeration areas (EAs) from the country's last national population census in 2006. Each locality in the 37 states was classified as urban and rural depending on the population size of ≥ /< 20,000 to give 74 sampling strata. One thousand and four hundred clusters of EAs were selected from each state with probability proportional to the enumeration area size. Thirty households were selected in each cluster through equal probability systematic sampling, resulting in a total sample size of 42,000 households. Forty thousand six hundred and sixty-six households were verified to be occupied with eligible women age 15-49 years for interview using questionnaires. The CSPro software package was used for data entry, editing, and tabulation (NPCN & ICF Macro, 2018).

Instruments used for 2018 NDHS Survey

The National Health Research Ethics Committee of Nigeria (NHREC) and the ICF Institutional Review Board (IRB) reviewed and approved the survey protocol including using questionnaires as the instruments to collect all required data. The use of the NDHS questionnaires was preceded by a series of training sessions on administering the data tools as well as biomarker data collection. Most of the participants for the exercise had previous experience of either conducting the NDHS surveys or the Nigeria Malaria Indicator Surveys (NMIS) (NPCN & ICF Macro, 2018). The ICF staff facilitated

all training focusing on the technical components of the survey, interview techniques, NDHS questionnaires completion procedures, and the administration of computer-assisted personal interviewing (CAPI) data collection system (NPCN & ICF Macro, 2018). The questionnaires were initially drafted and then finalized in English followed by a translation into the major languages in Nigeria including Hausa, Yoruba, and Igbo. The DHS protocol employed the CAPI system for data collection under the close supervision of experienced supervisors. Different learning tools and techniques were used for the training including role-plays, age probing in pairs, group discussion, in-class exercises, case studies, and presentations plenary lectures. The training also included discussions of the CAPI system, demonstrations of the CAPI DHS menus, and conducting of interviews through the CAPI system (NPCN & ICF Macro, 2018). Additionally, other tools were used including video and hands-on demonstrations on how to fill out the questionnaire and transmittal sheets, and instructions on data quality procedures followed by hands-on practice. All recruited participants were guided through the questionnaires. The field editors were trained on assigning households and receiving completed interviews from the interviewers, recognizing and dealing with error messages, receiving system updates and distributing updates to interviewers, entering biomarker questionnaires, implementing the re-measurement and re-visit questionnaires and the Biomarker Checklist, resolving duplicated cases, and closing clusters. The field editors were further trained on transferring interviews to the central office via the secure internet file streaming system (IFSS) developed by the DHS Program.

The involvement of experts for conducting the field survey in each of the 37 states in the country included identifying for each of the 37 states of the country supervisors and field editors based on their performance. Seventy-four and 111 male and female enumerators, 37 laboratory scientists, and 37 nurses were also selected and retrained on data quality control procedures, fieldwork coordination, and management for the survey. Each team of interviewers is made up of field supervisors, field editor, and four male and female interviewers including two drivers. Data quality was ensured through close monitoring and supervision of the technical team and trainers as quality controllers during the field activities. Data quality was also monitored through field checking of tables generated simultaneously with data processing procedures, which helped detect problems and alert the field teams as the data entry progressed. Five questionnaires were used as the instruments for data collection including the Household Questionnaire, the Woman's Questionnaire, Man's Questionnaire, the Biomarker Questionnaire, and the Fieldworker Questionnaire. Based on the DHS Program's standard Demographic and Health Survey (DHS-7), the questionnaires were adapted to reflect the population and health issues relevant to Nigeria. Comments were solicited from various stakeholders representing government ministries and agencies, Non – Governmental Organizations (NGOs), and international donors. The survey protocol was reviewed and approved by the National Health Research Ethics Committee of Nigeria (NHREC) and the ICF Institutional Review Board. After all, questionnaires were finalized in English, they were translated into Hausa, Yoruba, and Igbo. The 2018 NDHS used computer-assisted personal interviewing (CAPI) for data collection. The fieldwork for data collections using

the different questionnaires lasted between 14th August and 29th December 2018 under close supervision by state coordinators. Data collection in some states took longer than expected due to the security situation. The field workers encountered different challenges including security threats particularly in the north-east and northwest zones resulting in the cancellation of the exercise in some parts of some states (NPCN & ICF Macro, 2018).

Data Processing

The processing of the 2018 NDHS data was done concurrently as soon as the fieldwork commenced. The moment data were collected in each cluster, it was followed almost immediately with transfer of all the electronic data files through the IFSS to the NPC central office in Abuja. These data files were registered and checked for inconsistencies, incompleteness, and outliers. The field teams were alerted to any inconsistencies and errors. Secondary editing carried out in the central office, involved resolving inconsistencies and coding the open-ended questions. The NPC data processor coordinated the exercise at the central office. The biomarker paper questionnaires were compared with electronic data files to check for any inconsistencies in data entry. Data entry and editing were carried out using the CSPro software package. The concurrent processing of the data offered a distinct advantage because it maximized the likelihood of the data being error-free and accurate. Timely generation of field check tables allowed for effective monitoring. The secondary editing of the data was completed in the second week of April 2019.

Throughout this report, numbers in the tables reflect weighted numbers. Percentages based on 25 to 49 unweighted cases are shown in parentheses, and

percentages based on fewer than 25 unweighted cases are suppressed and replaced with an asterisk, to caution readers when interpreting data that a percentage based on fewer than 50 cases may not be statistically reliable.

Research Questions and Hypotheses

The following are the proposed research questions for my dissertation:

RQ1: Are there relationships between parents' socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status in Sokoto State, Nigeria?

*Ho1*A: There is no relationship between parents' socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status in Sokoto State, Nigeria.

*Ha1*A: There is a relationship between parents' socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status in Sokoto State, Nigeria.

RQ2: Are there relationships between parents' ethnoreligious affiliation (tribe/ethnicity and religious belief) and childhood vaccination status in Sokoto State, Nigeria?

*Ho2*A: There is no relationship between parents' ethnoreligious affiliation (tribe/ethnicity and religious belief) and childhood vaccination status in Sokoto State, Nigeria.

*Ha2*A: There is a relationship between parents' ethnoreligious affiliation (tribe/ethnicity and religious belief) and childhood vaccination status in Sokoto State, Nigeria.

RQ3: Are there relationships between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria?

*Ho3*A: There is no relationship between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria.

*Ha3*A: There is a relationship between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria.

RQ4: Are there relationships between a child's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria?

*Ho4*A: There is no relationship between a child's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria.

*Ha4*A: There is a relationship between a child's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria.

Operationalization of Variables

Table 2: Independent (Predictor) Variables of the Study

Hypothesis	Dependent (Outcome)	Independent/Predictor Variables		
		Variable	Definition of Variable	Scale of Measurement
*Ho1*A: There is no association between parental socioeconomic factors	Childhood vaccination status	Educational Level	Highest education attained (No formal=1; Primary =2;	Ordinal

(educational level, occupation, and wealth index) and childhood vaccination status in Sokoto State, Nigeria. *Ha1*A: There is an association between parental socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status in Sokoto State, Nigeria.			Secondary =3 & Post-Secondary=4)	
	Childhood vaccination status	Occupation	Parents/Caregivers occupation (Unemployed =1; Self-employed =2; Employed in Public Sector =3; & Employed in Private Sector =4)	Ordinal
	Childhood vaccination status	Wealth Index	Family wealth index (Poorest =1; Poorer = 2; Middle =3; Richer =4; & Richest =5)	Ordinal
*Ho2*A: There is no association between parental ethnoreligious (ethnicity/tribe and religious belief) affiliation and childhood vaccination status in Sokoto State, Nigeria. *Ha2*A: There is an association between parental ethnoreligious (ethnicity/tribe and religious belief) affiliation and childhood vaccination status in Sokoto State, Nigeria.	Childhood vaccination status	Tribe	Parents/Caregivers tribal group/ethnicity (Hausa/Fulani =1; Igbo = 2; Yoruba =3 & others =4)	Nominal
	Childhood vaccination status	Religious Belief	Parents/Caregivers religious affiliation (Christianity =1; Islam 2 & Traditional =3)	Nominal

*Ho3*A: There is no association between places of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria. *Ha3*A: There is an association between places of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria.	Childhood vaccination status	Places of residence (rural/urban),	Parents/caregivers' places of residence (Rural =1 & Urban =2)	Nominal
*Ho4*A: There is no association between children's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria. *Ha4*A: There is an association between children's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria.	Childhood vaccination status	Sex	Child's sex (Male =1 & Female =2)	Nominal
	Childhood vaccination status	Birth Order	Child's birth order in the family (First born =1; second born =2; third born =3 etc.)	

Table 3: Dependent (Outcome) Variable of the Study

Hypothesis	Independent (Predictor)	Dependent/Outcome Variable		
		Variable	Definition of Variable	Scale of Measurement
*Ho1*A: There is no association between parental socioeconomic factors (income and educational level) and childhood vaccination status in Sokoto State, Nigeria. *Ha1*A: There is an association between parental socioeconomic factors (income and educational level) and childhood vaccination status in Sokoto State, Nigeria.	Educational Level	Childhood vaccination status	Dichotomous (Incomplete =0 & Complete =1)	Nominal
	Occupation	Childhood vaccination status	Dichotomous (Incomplete =0 & Complete =1)	Nominal
*Ho2*A: There is no association between parental ethnoreligious (ethnicity/tribe and religious belief) affiliation and completion of childhood vaccination in Sokoto State, Nigeria. *Ha2*A: There is an association between parental ethnoreligious (ethnicity/tribe and religious belief) affiliation and completion of childhood vaccination in Sokoto State, Nigeria.	Tribe	Childhood vaccination status	Dichotomous (Incomplete =0 & Complete =1)	Nominal
	Religious Belief	Childhood vaccination status	Dichotomous (Incomplete =0 & Complete =1)	Nominal

*Ho3*A: There is no association between parental place of residence (rural/urban) and incomplete childhood vaccination in Sokoto State, Nigeria. *Ha3*A: There is an association between parental place of residence (rural/urban) and incomplete childhood vaccination in Sokoto State, Nigeria.	Places of residence (rural/urban),	Childhood vaccination status	Dichotomous (Incomplete =0 & Complete =1)	Nominal
*Ho4*A: There is no association between children's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria. *Ha4*A: There is an association between children's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria.	Sex	Childhood vaccination status	Dichotomous (Incomplete =0 & Complete =1)	Nominal
	Birth Order	Childhood vaccination status	Dichotomous (Incomplete =0 & Complete =1)	Nominal

Independent variables: Refer to parental socioeconomic factors including educational level, occupation, ethnoreligious background, place of residence, and children's biological characteristics.

Socioeconomic status: Refers to the educational level, occupation, and wealth index of the respondents (parents/caregivers). The scale of measurement for educational level is

ORDINAL because education levels of the respondents are on rank order. For example, respondents with secondary school certificate are higher in educational level than those who have primary school certificates. The scale of measurement for wealth index is **ORDINAL** as wealth is also on the rank order (Poorest =1; poor =2; middle =3; richer =4; and richest = 5). However, the scale of measurement for occupation is **NOMINAL** because the numbers assigned to each attribute (e.g. 1 = self-employed; 2 = Civil servant, etc.) do not have any significant value rather than just a label. That is, values 1 and 2 can stand for each attribute and mean the same.

Ethnoreligious background: Refers to the religious affiliation and tribe of the respondents. The scale of measurements for religious affiliation and tribe is **NOMINAL** because the value attached to each attribute is merely a label with no numerical significant value attached to it. For instance; **Religious affiliation**: 1 = Christian, 2 = Islam, 3 = Traditional etc. While **Tribe**: 1 = Hausa, 2 = Igbo, 3 = Yoruba etc. All the values (1, 2, and 3) attached to the above attribute does not mean one is higher than the other. All the attributes are equal, and each attribute can be attached with any number between 1 and 3.

Place of residence: Refers to the place of residence of parents in rural or urban areas. The scale of measurement for Place of residence of parents in rural or urban is also **NOMINAL** because the values "1 = Rural and 2 = Urban" are just labels attached with no significant numerical value attached. Either of the two "Rural and Urban" can take any number (i.e. 1 and 2) and means the same.

Children's biological characteristics: Refers to the sex of the child as well as birth order in the family. The scale of measurement for Sex is **NOMINAL** as values 1 and 2 stands for males and females respectively. In this regard, values 1 and 2 can be used interchangeably also equal. The scale of measurement for the Birth Order in the Family is **ORDINAL** because the firstborn of the family is greater in age than the second, third, fourth, etc. That is, the firstborn will be attached with 1, second born 2, third born 3, etc. In this regard, value number 1 is higher than 2, 3, etc.

Dependent variable: For this study, the dependent variable is childhood vaccination status among children ages 12 to 23 months. The interviewers collected information on immunization from mothers/caregivers from the children's immunization cards. A child is assumed to have completed immunization as per schedule after receiving a dose of BCG, three doses of DPT, three doses of polio, and a dose of measles vaccine. An incomplete childhood immunization refers to a child who missed a dose of BCG, any of the three doses of DPT and polio each, or a dose of measles vaccine at the age of 12-23 months. The scale of measurement for Childhood vaccination status is **NOMINAL** because it has two attributes; 1 = Completed and 2 = Not completed. Either 1 or 2 can stand for each attribute without signifying any numerical value attached to the number 1 and 2 rather than just a label.

Hypotheses Testing

The study outlined four research questions and two hypotheses (null and alternative) for each research question. The association between the independent variables (parents' socioeconomic factors, ethnoreligious affiliation, place of residence,

and children's biological characteristics) will be related to only one dependent variable which is the childhood vaccination status.

RQ1: The independent variable for RQ1 is parents' socioeconomic factors which have three dimensions namely parents' educational level, occupation, and wealth index.

RQ2: The independent variable for RQ1 is parents' ethnoreligious affiliation which also has two dimensions namely ethnicity/tribe and religious belief.

RQ3: Parents' place of residence as the independent variable for RQ3 has one dimension of rural or urban.

RQ4: Lastly, the independent variable for RQ4 is children's biological characteristics which have two dimensions namely sex and birth order.

In this regard, all the four independent variables have dimensions which were also specified in the proposed hypotheses of the study. Thus, the research tested the dimensions for each research question independently by running an appropriate statistics test. Chi-Square statistics was used to test the strength of relationship between the independent variables and the dependent variable. Similarly, logistic regression was used to test the predictive ability or influence of the independent variables on the dependent variable.

Data Analysis Plan

Data analysis involves the identification and measurement of variation in a set of variables, either among themselves or between a dependent variable and one or more independent variables (Gay & Airasian, 2000). Data for this study was obtained from

Nigeria Demographic and Health Survey (NDHS) and the data analyzed using SPSS software.

Exploratory Data Analysis

Generally, exploratory data analysis (EDA) is conducted to clean the data from errors including the normality test of the data distribution, linearity between the independent and dependent variables, and equality of variance (Komorowski et al., 2016; Natrella, 2010;). Additionally, Norusis (1992) suggested that through EDA, a researcher could examine in detail a variable or a set of variables before running any specific or confirmatory statistical analysis on any data collected. In long questionnaires, some participants accidentally miss out questions or deliberately refuse to complete/answer some questions especially on sensitive topics like sexual behavior (Field, 2013). In experimental procedures, mechanical faults or typographical errors can lead to a datum not being recorded (Field, 2013). The fact that there is missing information or data for some participants does not mean that the available data will be ignored. Nevertheless, the missing values for particular cases need to be coded in SPSS. To treat missing cases, Pallant (2011) and Field (2013) recommended putting a value as missing in the SPSS. Thus, 999 was coded in the missing values of some columns in SPSS to avoid ignoring the entire column for participant(s) due to few missing values. In a situation where the whole columns in some cases are missing, Pallant (2011) and Field (2013) suggested eliminating those cases to avoid system missing data in the analysis.

Preliminary analysis was done for missing values to find out if the assumptions of the selected tests were met or violated, and if other patterns existed. Before undertaking

the statistical analysis for the quantitative study, exploratory data analysis was carried out for all the variables. EDA was conducted to free the data from all types of errors and assess the frequency distribution of the data, checking for missing values, and outliers. While descriptive analyses were used to describe the patterns for all variables, inferential statistics was used to test the hypotheses of the study. All these are aimed at identifying errors so that necessary correction, smoothening, and re-expression of data can be made easily.

Descriptive Analysis

Descriptive analyses are merely summaries of the data that include statistics such as the mean, median, mode, standard deviations, range, frequency, percentage, kurtosis, skewness, and so forth. As mentioned by Walker (2005) that, descriptive statistics provide an account of the characteristics of individuals, groups, or situations that may form the first stage of data analysis. Descriptive statistics is commonly used to examine and summarize a large amount of data. The means, standard deviations, and frequencies are measures of central tendency and measures of variability of descriptive statistics to show how many respondents answered questions with each particular response. It is a percentage for each of the frequency distribution (Anderson, MacLellan-Wright, & Barber, 2007). Descriptive statistics can be used in several ways, including helping to describe the characteristics of the study sample in the method section. Descriptive statistics also helps in addressing specific research questions, and in checking the variables in the case of violation of the assumptions underlying the statistical techniques that the researcher uses to address the research questions. For this study, descriptive

statistics was used for exploratory data analysis to describe the background characteristics of the respondents, patterns of, and levels of variables of the study. The SPSS statistical software was used to disaggregate data by parents' socio-demographic variables including socioeconomic characteristics (educational level, occupation, and wealth index), ethnoreligious affiliation (tribe/ethnicity and religious belief), place of residence (urban or rural), and children's biological factors (gender and birth order) and childhood vaccination status in Sokoto state, Nigeria. The Pearson Chi-square statistics and simple/multiple logistic regression were used to test for the strength of associations between the variables.

Inferential Statistics

Inferential statistics, on the other hand, was used to compute differences of mean and analyze the association between variables to draw a logical conclusion on the relationship, association, or differences between variables that cannot be simply attributed to mere chance. The primary purpose of inferential statistics is to estimate or predicts population characteristics from a sample. In this study, the inferential statistics used included the Pearson Chi-Square statistics and the Logistics Regression analysis.

Pearson Chi-Square Statistics

Chi‑square statistics is a nonparametric test used to test the association between two or more categorical variables. According to Rana and Singhal (2015), the Chi-Square test is used for two specific reasons which include testing the hypothesis for association between two or more groups, population or criteria (i.e. to check independence between two variables), and testing how likely the observed distribution of data fits with the

distribution that is expected (i.e., to test the goodness-of-fit). In this study, chi-square statistics was used to determine the association between the independent variables of the study, which include parents' socioeconomic factors (income and educational level), ethnoreligious affiliation (ethnicity and religion), place of residence [rural/urban], and the children's biological characteristics (sex and birth order), with the dependent variable of completion of childhood immunization.

Logistic Regression Analysis

Generally, logistic regression is well suited for describing and testing hypotheses about relationships between a categorical outcome variable and one or more categorical or continuous predictor variables (Peng, Lee & Ingersoll, 2002). Logistic regression estimates the effect of categorical or continuous independent variable on a categorical dependent variable (Field, 2013). For this study, logistic regression was utilized to estimate the influence of independent variables including parental socioeconomic factors (income, occupation, and educational level), ethnoreligious affiliation (ethnicity and religion), place of residence, and children's biological characteristics (sex and birth order) on the dependent variable (childhood vaccination status).

Analysis by Research Questions

Research Question 1: The relationship between parents' socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status was determined using Pearson Chi-square statistics. Similarly, logistic regression analysis was used to estimate the influence of the socioeconomic factors (educational level, occupation, and wealth index) on childhood vaccination status.

Research Question 2: Similarly, Pearson Chi-square analysis was used to estimate the relationship between parents' ethnoreligious affiliation and childhood vaccination status while logistic regression was used to determine the effect of tribe/ethnicity and religious belief on childhood vaccination status. The Chi-square tested only the association between variables while the BLR tested the effects of IVs on DV. Although both tested relationships, Chi-square tested the direction of relationship while BLR tested the contribution of IV on DV.

Research Question 3: The relationship between parents' place of residence (rural and urban) and childhood vaccination status was also examined. The effect of parents' place of residence on childhood vaccination status estimated using logistic regression analysis.

Research Question 4: The relationship between children's biological characteristics (sex and birth order) and childhood vaccination status was determined. A simple logistic regression analysis was applied to examine the predictive ability of children's biological characteristics on childhood vaccination status.

Finally, a multiple logistic regression analysis was used to determine the adjusted odds ratio (AOR) to control for other variables in the final model. Andresen and Bouldin (2010) suggested that, adjusted odds ratio (AOR) is an odds ratio that controls for other predictor variables in a multiple regression model. It gives an idea of the dynamics between the predictors in relation to the outcome variable (Meyers et al., 2013).

Scope and Delimitation of the Study

This study is limited to Sokoto state, north-west, Nigeria. The aim of the study is to identify the socio-demographics factors associated with the low childhood vaccination

in Sokoto state. The association between the independent variables (parents' socioeconomic factors, ethnoreligious affiliation, place of residence, and children's biological characteristics) and the childhood vaccination status (dependent variable) was examined using the social ecological mode as the theoretical framework. Therefore, the findings of this study could be generalized to the population of Sokoto state only because the characteristics of the sampled respondents may differ from the population of other states and other geopolitical zones in Nigeria and other countries.

Limitations of the Study

This study is limited to Sokoto state only without taking into consideration the neighboring states in the north-west zone or other parts of Nigeria due to the persistently low routine immunization coverage during all surveys conducted in the country in the last ten years including NDHS 2008, 2013, and 2018. Secondly, the study covered only the variables measured (parents' socioeconomic factors, ethnoreligious affiliation, place of residence, and children's biological characteristics as independent variables and childhood vaccination status as outcome variable. Since Sokoto and other states in the northern part of Nigeria have experience recurrent outbreaks of childhood vaccine-preventable diseases, there is the need to conduct further studies to understand the responsible factors better and implement specific interventions to address the challenges. The use of secondary data is commonly associated with missing values in the data set (as seen in the 2018 NDHS dataset where 36 cases had missing values and were deleted). Additionally, it is difficult to control for the confounders that have been identified in

other previous studies (such variables may not have been collected during the primary data collection stage (Smith et al., 2011)

Threats to Validity

The study is based on analysis of secondary data which has been validated by ICF International, the technical support through the USAID-funded MEASURE DHS program, designed to help low-resource countries with data collection on fertility, family planning, and maternal and child health (NPCN & ICF Macro, 2018). However, there might still be limitations to construct validity, limited or missing variables, unaccounted errors in data collection, and so on. To minimize these threats, the data was further revalidated using the SPSS preloaded rules to pass the validation checks. Due to the serious level of insecurity in forms of abductions for ransom from 2016 to 2018 in Sokoto and other north-west states of Nigeria, enumerators might not have reached all communities to collect data (NPCN & ICF Macro, 2018).

Ethical Procedures

The 2018 Nigeria Demographic and Health Survey (2018 NDHS) was conducted by the National Population Commission (NPC) in collaboration with the National Malaria Elimination Program (NMEP) of the Federal Ministry of Health, Nigeria. The United States Agency for International Development (USAID), Global Fund, Bill and Melinda Gates Foundation (BMGF), the United Nations Population Fund (UNFPA), and World Health Organization (WHO) provided the funding for the survey. The ICF Maryland provided technical assistance through the DHS Program, a USAID-funded project providing similar support in the implementation of population and health surveys

in other countries worldwide. The Institutional Review Board (IRB) of the United States of America (USA) approved the proposal and the protocol to conduct the DHS. Nigeria's National Health Research Ethics Committee (NNHREC) also independently reviewed and approved the study (NPCN & ICF Macro, 2018). The authorization to access the 2018 NDHS data was sought from the custodians of the data, ORC Macro and ICF International, based in Calverton Maryland, USA (USAID & ICF Macro, 2018). The database is currently housed in the domain called MEASURES DHS+ and supported by the USAID.

This study is an indirect research with human subjects because it only involved analysis of the secondary datasets by focusing on the significant variables collected in the 2018 NDHS survey. For this reason, I applied and obtained the official approval to use the dataset from the custodians of the data, ORC Macro and ICF International, based in Calverton Maryland, USA (USAID & ICF Macro, 2018). With the approval, I had full access to retrieve all required dataset, saved on my laptop, and used the data for the study. An important next step is to publish the findings after the study. The permission to carry out this study using the 2018 DHS data was granted by the Institutional Review Board (IRB) of Walden University via an e-mail dated August 6th, 2020 with an IRB approval number08-05-20-0469261.The datasets were reviewed after retrieval as well as the data dictionary to ensure all expected variables are not missing. After accessing and using the data for analysis, it will be deleted from the system when the study is completed.

Summary

The third chapter of the study dwelled on a detailed description of the research design, rationale, and methodology to be used. In Chapter 3, I described the study population, sample design, sampling procedure, data collection and abstraction, participants' recruitment procedures, study variables, data analysis plan, and ethical considerations. The additional section of the chapter summarized the research design (cross-sectional quantitative approach of inquiry), rationale and methodology of the study. The methodology entails describing in detail how enumeration areas (EAs) were derived from the 2006 national census, managing secondary data, sampling and sampling procedure, instrumentation, and operationalization of constructs. Variables were operationalized by defining the dependent and independent variables and their means of measurement, data collection, and management techniques, and data analysis plan. In the next chapter (Chapter 4), I presented the results of the study alongside a description of the collected data and procedures for analysis in a quantitative cross-sectional design. In this chapter, the time frame for data collection, actual recruitment, and response rates of the participants was described in addition to discussing findings from the statistical basic univariate, bivariate, and multivariate analyses.

Chapter 4: Results

The purpose of the study was to examine the existence of a relationship between the socio-demographic factors and childhood vaccination status in Sokoto State, Nigeria, using a secondary dataset from the 2018 DHS. The 2018 NDHS is a nationally representative study that covered all the 37 states of the country. Nationally, the study involved 41,821 eligible women aged 15-49 years in 40,666 occupied households with 1,919 from Sokoto state. The methodology for collecting the data used in the analysis was discussed in the preceding chapter. Pearson Chi – square was used to determine the relationship between parents' socioeconomic factors (income, occupation, and educational level), ethnoreligious affiliation (religion and ethnicity), place of residence (urban or rural), and children's biological characteristics (sex and birth order) with childhood vaccination status. Simple and multiple logistic regression analyses models were used to estimate the predictive ability of the independent variables on the outcome variable.

Descriptive Data

Immunization Status

Among the 1,883 respondents selected for the study, the descriptive analysis in Table 4 below shows the distribution of the parents whose children did not complete and who completed all the childhood vaccination as per Nigeria's recommended schedule. Nigeria's current immunization schedule classifies a child as fully vaccinated by first birthday upon receiving a dose of BCG at birth, three doses of DTP (also called pentavalent vaccine) and oral polio vaccine at 6, 10, and 14 weeks, and a dose of measles

vaccine at 9 months of age (NPHCDA Nigeria, 2017). The result revealed that the respondents who did not complete routine immunization constituted the majority (96.2%) compared to only 3.8% that completed the doses of the various vaccines.

Socio-Economic Characteristics of the Parents

Table 4 below is a descriptive analysis of the educational level, occupation, and wealth index of the 1,883 respondents. The respondents with no education constituted the majority (66.4%) followed by the secondary level 18.4% (both junior secondary school or the sixth through eighth grade and the senior secondary school or the ninth through twelfth grade), and higher education (7.6%). The respondents with primary level education constituted the least proportion (7.5%). The respondents also differ on the types of occupation with the sales and services constituting the highest proportion (50.0%), followed by agriculturalists at 26.9%, and not working/unskilled manual workers at 12.4%. The proportion of professional/technical/managerial and the skilled manual workers constituted the least categories of only 6.7% and 4.1%, respectively.

The 2018 DHS data collected information on assets owned by the family of each respondent. Family wealth index categorization used the responses from the specific questions on individual income level collected during the survey (NPC & ICF Macro, 2018). Information was collected on household assets including owning televisions, refrigerators, vehicles, houses, and so on to assess the family wealth indexes a guide to classifying the standard of living of the families. Calculation of the FWI was possible through scores allocated to each type of asset and categorized into wealth quintiles including poorest, poorer, middle, richer, and richest (NPC & ICF Macro, 2018). Table 4

below shows the family wealth index with the poorest respondents constituting the majority (42.3%), followed by the poorer (19.2%), and the richest (16.8%). Those in the middle (10.9%) and richer (10.7%) classes are the least compared with the poorest and poorer classes.

Table 4

Socio-Economic Characteristics of the Respondents (N = 1883)

Variables	Frequency	Percent
Childhood vaccination status		
Not completed	1,811	96.2
Completed	72	3.8
Education level		
No education	1,251	66.4
Primary education	142	7.5
Secondary education	346	18.4
Higher education	144	7.7
Occupation		
Not working/unskilled manual	233	12.4
Professional/technical/managerial	126	6.7
Sales/services	941	50.0
Skilled manual	77	4.1
Agricultural	506	26.8
Wealth index		
Poorest	797	42.3
Poorer	362	19.2
Middle	206	10.9
Richer	201	10.7
Richest	317	16.8

Ethno-Religious Characteristics of the Respondents

The respondents also differ on types of ethnic background. The findings in Table 5below indicate that the Hausa/Fulani are the majority of the respondents (67.8%), while other tribes (Yoruba, Igbo, etc.) are the minority (32.2%). For the religious background, the majority of the respondents in the study area are Muslims (80.2%), while Christians constitute only 19.8%.

Table 5

Ethno-Religious Characteristics of the Respondents (N = 1883)

Variables	Frequency	Percent
Ethnicity/tribe		
Hausa/Fulani	1,277	67.8
Others	606	32.2
Religious affiliation		
Christians	373	19.8
Muslims	1,510	80.2

Place of Residence of the Respondents

Regarding the type of residence of the respondents in Table 6 below, those residing in the rural areas are the majority constituting 68.2% compared to urban residents (31.8%).

Table 6

Place of Residence of the Respondents (N = 1883)

Variables	Frequency	Percent
Place of residence		
Urban	599	31.8
Rural	1,284	68.2

Biological Characteristics of the Respondents' Children

The sex and birth orders of the respondents' children are depicted in Table 7 below. The proportion of the female respondents (52.4%) is slightly higher than that of male (47.6%). Table 7 further displays the percentage and frequency distribution of children's birth order in the study area. Respondents who have one to four children are the majority (65.9%), followed by five to eight children (27.3%) and nine children and above (6.8%).

Table 7

Biological Characteristics of the Respondents (N = 1883)

Sex of children	Frequency	Percent
Male	896	47.6
Female	987	52.4
Birth order		
1-4 Children	1241	65.9
5-8 Children	515	27.3
9Children& above	127	6.8

Hypothesis Testing: Relationship Between Parent's Socio-Economic Factors, Ethno-Religious Affiliation, Place of Residence, and Children's Biological Characteristics and Childhood Vaccination Status.

Pearson Chi-Square analysis was used to determine the relationship between the independent and dependent variables, while simple logistic regression analysis was conducted to test the hypotheses for these relationships.

Research Questions

RQ1: Are there relationships between parents' socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status in Sokoto state, Nigeria?

The Pearson Chi-Square analysis in Table 8 below shows that there is a significant relationship between education level and childhood vaccination status [(χ^2 (3, N = 1883)] = 37.498, Cramer's V = .141, p = .000)]. The descriptive statistics for childhood vaccination status across the four categories of education level indicates that the respondents who did not complete childhood vaccination (1,817 or 96.5%) are

significantly higher than those who completed RI (66 or 3.5%). Amongst the non-completers, the respondents with no education constituted the majority (67.3%), while those with higher education are the lowest (7.0%). For the primary and secondary level education categories, only 7.6% and 18.1% did not complete childhood vaccination, respectively, compared with 67.3% of respondents with no education. This signifies that the higher the education level, the higher the childhood vaccination completion rates.

Table 8

Pearson Chi-Square of the Relationship Between Education Level and Childhood Vaccination Status

	Childhood Vaccination Status						
Independent variable	Not completed	Completed	Total	*Df*	χ^2 – Stat.	Cramer's V	Sig-χ^2
Education level				3	37.498	.141	.000
No education	1, 223 (67.3%)	28 (42.4%)	1, 251				
Primary education	138 (7.6%)	4 (6.1%)	142				
Secondary education	329 (18.1%)	17 (25.8%)	346				
Higher education	127 (7.0%)	17 (25.7%)	144				
Total	1817	66	1883				

Hypothesis test for RQ1:

$H_0$1: There is no relationship between parents' educational level and childhood vaccination status in Sokoto state, Nigeria.

H_a1: There is a relationship between parents' educational level and childhood vaccination status in Sokoto state, Nigeria.

A Simple Binary Logistic Regression using Enter Method was performed to determine the effect of education level on the likelihood that the respondents have

completed their childhood vaccination or not. Dichotomous options of "Not completed = 0 and Completed = 1" were used. The logistic regression model in Table 9 containing only 1 independent variable (education level) is statistically significant [(χ^2 (3, N = 1883) = 27.250, p = .000)]. This indicates that the model was able to distinguish between respondents who "have not completed = 0" and those who "have completed = 1" their vaccination schedule. Also, the result shows that between 1.4% Cox and Snell R square (0.014 × 100) and 5.5% Nagelkerke R square (0.055 × 100) of the variance in childhood vaccination status (not completed or completed) was explained by education level variable; and correctly classified 96.5% of cases.

The result in Table 9 below reveals that there is a significant effect of education level on childhood vaccination status by indicating the OR = 2.257, p = .009 (95% CI: 1.220, 4.174) for secondary education and OR = 5.847, p = .000 (95% CI: 3.115, 10.975) for higher education level. But the primary education level has no significant effect on childhood vaccination status. This means that the respondents with secondary and higher education levels have almost two times and five times higher childhood vaccination completion rate respectively than the respondents with no education level. After controlling for the compounding variables in the model, the result for the adjusted odds ratio indicated no significant effect of education level [(primary education AOR = .425, p = .195 (95% CI: .116, 1.553); (secondary education AOR = .751, p = .597 (95% CI: .260, 2.168); (higher education AOR = 2.534, p = .152 (95% CI: .710, 9.042)] on childhood vaccination status.

Table 9

Regression Result of Effects of Education on Childhood Vaccination Status

	Simple Logistic Regression				Multivariate Logistic Regression			
			95% C.I. for EXP(B)				95% C.I. for EXP(B)	
Variable	OR	*p*	Lower	Upper	AOR	*p*	Lower	Upper
Education level								
Primary education	1.266	.663	.438	3.663	.425	.195	.116	1.553
Secondary education	2.257	.009	1.220	4.174	.751	.597	.260	2.168
Higher education	5.847	.000	3.115	10.975	2.534	.152	.710	9.042
For SLR: Cox and Snell R^2 = .014; NagelkerkeR^2 = .055; [(χ^2 (3, N = 1883) = 27.250, *p* = .000)]								

a. Variable(s) entered on step 1: Education level

Note: OR: - Odd Ratio; AOR: - Adjusted Odd Ratio; *p*:- p – value; CI:- Confidence Interval; SLR:- Simple Logistic Regression.

Table 10 below shows the occupation of the respondents. From the table, occupation has a significant influence on childhood vaccination status [(χ^2 (4, N = 1883) = 9.923, Cramer's V = .073, *p* = .042)]. The descriptive statistics for childhood vaccination status across the five categories of occupation revealed that the respondents who did not complete childhood vaccination are significantly higher (96.2%) than those who completed their childhood vaccination (3.8%). Amongst the respondents that did not complete childhood vaccination, those working in sales/ services are the majority (50.1%), followed by the agriculturalists (26.9%) and not working/ unskilled manual workers (12.1%). The skilled manual respondents have the lowest proportion of non-completers of childhood vaccination (4.1%), followed by the

professional/technical/managerial category (6.1%). This implies that skilled and professional respondents have more of their children completing RI as per schedule compared with the unskilled and unemployed respondents.

Table 10

Pearson Chi-Square of the Relationship Between Occupation and Childhood Vaccination Status

	Childhood vaccination status						
Independent variable	Not Completed	Completed	Total	*df*	χ^2 – Stat.	Cramer's V	Sig-χ^2
Occupation				4	9.923	.073	.042
Not working/unskilled manual	229 (12.8%)	4 (4.5%)	233				
Skilled manual	74 (4.1%)	3 (3.4%)	77				
Sales/services	898 (50.1%)	43 (48.3%)	941				
Agricultural	482 (26.9%)	24 (27.0%)	506				
Professional/technical/managerial	111 (6.1%)	15 (16.8%)	126				
Total	1,794	89	1,883				

Ho1B: There is no relationship between parents' occupation and childhood vaccination status in Sokoto State, Nigeria.

Ha1B: There is a relationship between parents' occupation and childhood vaccination status in Sokoto State, Nigeria.

The Simple Logistic Regression model of childhood vaccination status and respondent's occupation in Table 11 below is statically significant ($\chi 2$ [(χ^2 (4, N = 1883) = 10.253, p = .036]. This means that the model distinguished between respondents who "have not completed = 0" and those who "have completed = 1" their routine immunization according to the types of occupation. The result generated by the Simple Logistic Regression Model shows that between 0.5% Cox and Snell R square (0.005 × 100) and 1.7% Nagelkerke R squared (0.017 × 100) of the variance in childhood vaccination status was explained by occupation; and correctly classified 96.5% of cases. Additionally, the finding in Table 11 further revealed that there is a significant effect of occupation on childhood vaccination status as shown by the OR = .252, p = .044 (95% CI: .060, .586) for Professional/Technical/Managerial only. However, the remaining occupation categories were found to be non-significant. This implies that the respondents who are engaged in Professional/Technical/Managerial activities have almost 0.3 times higher childhood vaccination completion rate compared to the Not Working/Unskilled Manual category. After controlling for the compounding variables using Multiple Logistic Regression, the result revealed no significant effect of occupation categories on childhood vaccination status.

Table 11

Regression result for effects of parents' occupation on Childhood Vaccination Status

	Simple Logistic Regression				Multivariate Logistic Regression			
			95% C.I. for EXP(B)				95% C.I. for EXP(B)	
Variable	OR	*p*	Lower	Upper	AOR	*p*	Lower	Upper
Occupation								
Professional/Technical//Managerial	.252	.044	.066	.962	.640	.472	.190	2.158
Sales/Services	.690	.446	.265	1.795	.555	.261	.199	1.549
Skilled Manual	1.377	.567	.460	4.127	.268	.064	.066	1.079
Agricultural	.717	.512	.265	1.939	.891	.830	.309	2.564
For SLR: Cox and Snell R^2 = .005; NagelkerkeR^2 = .017; [(χ^2 (4, N = 1883) = 10.253, *p* = .036]								

a. Variable(s) entered on step 1: Occupation

Note: OR:- Odd Ratio; AOR:- Adjusted Odd Ratio; *p*:- p – value; CI:- Confidence Interval; SLR:- Simple Logistic Regression.

For the family wealth index groups, the Pearson Chi-Square analysis in Table 12 below shows that there is a significant relationship between family wealth index and childhood vaccination status [(χ^2 (4, N = 1883) = 21.475, Cramer's V = .107, *p* = .000)]. The descriptive statistics for childhood vaccination status across the 5 classes of family wealth index shows that the respondents who did not complete childhood vaccination (1817) are significantly greater than those who completed their childhood vaccination (66). The Poorest respondents have the highest proportion of Not Completed childhood vaccination (43.0%) followed by the Poorer respondents (19.5%) while the Richest class have the lowest proportion of Not Completed childhood vaccination (10.5%). This shows

that the higher the family wealth index, the higher the childhood immunization completion rate across the 5 categories of respondents. This is evidenced by the fact that just as the Poorest respondents have nearly four times the population of those in the Richest category, the latter have 4 times the odds of completion of childhood vaccination than the former.

Table 12

Pearson Chi-Square of the relationship between family wealth index and Childhood Vaccination Status

	Childhood Vaccination Status						
Independent Variable	Not Completed	Completed	Total	*df*	χ^2 – Stat.	Cramer's V	Sig-χ^2
Wealth Index				4	21.475	.107	.000
Poorest	782 (43.0%)	15 (22.7%)	797				
Poorer	354 (19.5%)	8 (12.1%)	362				
Middle	195 (10.7%)	11 (16.7%)	206				
Richer	296 (16.3%)	11 (16.7%)	317				
Richest	190 (10.5%)	21 (31.8%)	201				
Total	1,817	66	1,883				

Ho1C: There is no relationship between family wealth index and childhood vaccination status in Sokoto State, Nigeria.

Ha1C: There is a relationship between family wealth index and childhood vaccination status in Sokoto State, Nigeria.

The result of the Simple Binary Logistic Regression model of RI status and family wealth index in Table 13 below showed that the model is statically significant [(χ^2

(4, N = 1883) = 20.521, *p* = .000)]. This means that the model was able to distinguish between respondents who "have not completed = 0" and those who "have completed = 1" their routine immunization based on the family wealth index levels. The result of model summary revealed that between 1.1% Cox and Snell R square (0.011 × 100) and 4.1% Nagelkerke R squared (0.041 × 100) of the variance in childhood vaccination status was explained by family wealth index; and correctly classified 96.5% of cases. The result of the regression coefficient revealed that there is a significant effect of wealth index among the respondents on childhood vaccination status based on the OR = 2.941, *p* = .008 (95% CI: 1.330, 6.504) for Middle Class; OR = 3.018, *p* = .006 (95% CI: 1.364, 6.677) for Richer Class; and OR = 3.699, *p* = .000 (95% CI: 1.881, 7.271) for Richest Class. However, the result has shown that there is no significant effect of Poorer Class on childhood vaccination status, OR = 1.178, p = .711 (95% CI: .495, 2.804). This means the respondents in the Middle, Richer, and Richest Classes are two times, three times, and almost four times higher childhood vaccination completion rate respectively compared to the respondents in the Poorest Class. After controlling for the compounding variables using multiple logistic regression, the finding has shown that there is a significant effect of only the Richest Class on childhood vaccination status (AOR = 2.815, *p* = .022 (95% CI: 1.159, 6.836) which indicated a decrease in adjusted odd ratio.

Table 13

Regression result for family wealth index

	Simple Logistic Regression				Multivariate Logistic Regression			
			95% C.I. for EXP(B)				95% C.I. for EXP(B)	
Variable	**OR**	***p***	**Lower**	**Upper**	**AOR**	***p***	**Lower**	**Upper**
Wealth Index								
Poorer	1.178	.711	.495	2.804	1.003	.995	.418	2.405
Middle	2.941	.008	1.330	6.504	1.577	.422	.519	4.790
Richer	3.018	.006	1.364	6.677	1.506	.497	.462	4.911
Richest	3.699	.000	1.881	7.271	2.815	.022	1.159	6.836
For SLR: Cox and Snell R^2 = .011; NagelkerkeR^2 = .041; [(χ^2 (4, N = 1883) = 20.521, *p* = .000)]								

a. Variable(s) entered on step 1: Wealth Index

Note: OR:- Odd Ratio; AOR:- Adjusted Odd Ratio; *p*:- p – value; CI:- Confidence Interval; SLR:- Simple Logistic Regression.

Research Question 2

RQ2: Are there relationships between parents' ethnoreligious affiliation (ethnicity/tribe and religious belief) and childhood vaccination status in Sokoto State, Nigeria?

Table 14 below illustrates the Chi-Square analysis of ethnicity and childhood vaccination status with the analysis revealing that there is a significant relationship between the two variables, [(χ^2 (1, N = 1883) = 25.318, Phi = .116, *p* = .000)]. The descriptive analysis of childhood vaccination status shows that just as the Hausa/Fulani ethnic group constitute the majority of the respondents (67.8%), they have the higher

proportion of non-completers of childhood vaccination (68.4%) than the other tribes (31.6%). That implies that the Other Tribes have 50% higher childhood vaccination completion rate compared to the Hausa/Fulani ethnic group.

Table 14

Pearson Chi – Square of the relationship between ethnicity and Childhood Vaccination Status

	Childhood Vaccination						
Independent Variable	Not Completed	Completed	Total	df	χ^2 – Stat.	Phi	Sig-χ^2
Ethnicity				1	25.318	.116	.000
Hausa/Fulani	1, 251 (68.4%)	26 (39.4%)	1,277				
Other Tribes	566 (31.6%)	40 (60.6%)	606				
Total	1,817	66	1,883				

Hypothesis test for RQ2:

*Ho2*A: There is no relationship between parents' ethnicity/tribe and childhood vaccination status in Sokoto State, Nigeria.

*Ha2*A: There is a relationship between parents' ethnicity/tribe and childhood vaccination status in Sokoto State, Nigeria.

Simple logistic regression model containing ethnicity variable is statistically significant [(χ^2 (1, N = 1883) = 23.283, p = .000)] as shown in Table 15 below. The model was able to distinguish between respondents who "have not completed = 0" and those who "have completed = 1" their childhood immunization. The result generated by

model summary revealed that between 1.2% Cox and Snell R square (0.012 × 100) and 4.7% Nagelkerke R squared (0.047 × 100) of the variance in childhood vaccination status was explained by ethnicity of the respondents, and correctly classified 96.5% of cases. Additionally, the result from the table shows that there is a significant effect of ethnicity on childhood vaccination status among the respondents based on the OR = 3.400, *p*= .004 (95% CI: 2.055, 5.627) for other tribes. The result shows that other tribes have three times higher childhood vaccination completion rate compared to Hausa/Fulani ethnic group. Likewise, after controlling for the confounding variables using Multiple Logistic Regression, there is still a significant effect of other tribes on childhood vaccination status [AOR = 4.024, p= .004 (95% CI: 1.540, 10.513)]. There is a significant increase in the adjusted odds ratios of other tribes in terms of completing childhood vaccination compared to the Hausa/Fulani tribe in the study area.

Table 15

Regression result for parents' ethnicity/tribe on Childhood Vaccination Status

	Simple Logistic Regression				Multivariate Logistic Regression			
			95% C.I. for EXP(B)				95% C.I. for EXP(B)	
Variable	OR	*p*	Lower	Upper	AOR	*p*	Lower	Upper
Ethnicity								
Other Tribes	3.400	.000	2.055	5.627	4.024	.004	1.540	10.513
For SLR: Cox and Snell R^2 = .012; NagelkerkeR^2 = .047; [(χ^2 (1, N = 1883) = 23.283, *p* = .000)]								

a. Variable(s) entered on step 1: Ethnicity

Note: OR:- Odd Ratio; AOR:- Adjusted Odd Ratio; *p*:- p – value; CI:- Confidence Interval; SLR:- Simple Logistic Regression.

The result in Table 16 below shows that there is no significant relationship between religious inclination and childhood vaccination status [(χ^2 (1, N = 1883) = 12.364, Phi = .081, p = .000)]. The predominant religious inclination in Sokoto state is Islam with majority of the respondents being Muslims (80.2%) compared with the fewer Christians (19.8%). However, the proportion of Muslims who did not complete childhood vaccination (80.9%) is much higher than that of the Christians (19.1%). All the respondents in Sokoto state are either Muslims or Christians with no other religious affiliations like the traditionalists as seen in other parts of Nigeria.

Table 16

Pearson Chi – Square of the relationship between religion and Childhood Vaccination Status

	Childhood Vaccination						
Independent Variable	Not Completed	Completed	Total	*df*	χ^2 – Stat.	Phi	Sig-χ^2
Religion				1	12.364	.081	.000
Christians	343 (19.1%)	30 (34.5%)	373				
Muslims	1453 (80.9%)	57 (65.5%)	1,510				
Total	1,796	87	1,883				

Ho2B: There is no relationship between parents' religion and childhood vaccination status in Sokoto State, Nigeria.

Ha2B: There is a relationship between parents' religion and childhood vaccination status in Sokoto State, Nigeria.

The simple logistic regression model of religion and childhood vaccination status in Table 17 is statistically significant [(χ^2 (1, N = 1883) = 10.797, p = .001)]. The result from the model summary indicated that between 0.6% Cox and Snell R square (0.006 × 100) and 1.8% Nagelkerke R squared (0.018 × 100) of the variance in childhood vaccination status was explained by religious background of the respondents, and correctly classified 96.5% of cases. Additionally, the finding in Table 17 below revealed that the religious background of the respondents have a significant effect on childhood vaccination status by indicating OR = .449, p= .001 (95% CI: .284, .709) for Christians respondents. This means that Christians have almost 50% higher childhood completion rate than the Muslims in the study area. However, after controlling for the compounding variables using Multiple Logistic Regression, the result indicated no significant effect of religious background (Christians) on childhood vaccination status [AOR = 1.948, p= .056 (95% CI: .983, 3.861)].

Table 17

Regression result for parents' religion on Childhood Vaccination Status

	Simple Logistic Regression				Multivariate Logistic Regression			
			95% C.I. for EXP(B)				95% C.I. for EXP(B)	
Variable	OR	*p*	Lower	Upper	AOR	*p*	Lower	Upper
Religion								
Christians	.449	.001	.284	.709	1.948	.056	.983	3.861
For SLR: Cox and Snell R^2 = .006; NagelkerkeR^2 = .018; [(χ^2 (1, N = 1883) = 10.797, p = .001)]								

a. Variable(s) entered on step 1: Religion

Note: OR:- Odd Ratio; AOR:- Adjusted Odd Ratio; *p*:- p – value; CI:- Confidence Interval; SLR:- Simple Logistic Regression.

Research Question 3

RQ3: Are there relationships between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria?

The Pearson's Chi-Square analysis in Table 18 below shows that there is a significant relationship between place of residence and childhood vaccination status [(χ^2(1, N = 1883) = 11.418, Phi = .078, p = .001)]. The descriptive analysis of Not Completed childhood vaccination shows that rural dwellers constitute the majority (68.2%) of the respondents compared with the urban dwellers (31.8%). In terms of Not Completed childhood vaccination, the rural respondents (69.1%) are the majority compared with Urban respondents (30.9%). This shows that the Urban dwellers have 69.1% higher childhood vaccination completion rate compared to the Rural dwellers.

Table 18

Pearson Chi – Square of the relationship between place of residence and Childhood Vaccination Status

	Childhood Vaccination						
Independent Variable	Not Completed	Completed	Total	*df*	χ^2 – Stat.	Phi	Sig-χ^2
Place of Residence				1	11.418	.078	.001
Urban	558 (30.9%)	41 (53.2%)	599				
Rural	1, 248 (69.1%)	36 (46.8%)	1,284				
Total	1,806	77	1,883				

Hypothesis test for RQ3:

*Ho3*A: There is no relationship between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria.

*Ha3*A: There is a relationship between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto State, Nigeria.

In line with the hypothesized relationship of the place of residence and childhood vaccination status in Table 19 below, the result of the Simple Binary Logistic Regression model containing place of residence is statically significant [(χ^2 (1, N = 1883) = 10.659, p = .001)]. This revealed that the model was able to differentiate between respondents who "have not completed = 0" and those who "have completed = 1" their routine immunization based on their type of place of residence in the study area. The result produced by the Simple Logistic Regression Model shows that between 0.6% Cox and Snell R square (0.006 × 100) and 2% Nagelkerke R squared (0.020 × 100) of the variance in childhood vaccination status was explained by place of residence of the respondents, and correctly classified 96.2% of cases. The result in Table 19 further revealed that there is a significant effect of place of residence on childhood vaccination status by indicating OR = .451, p = .001 (95% CI: .281, .724) for urban residents. This means that, respondents who are residing in urban area have 50% higher immunization completion rate compared to those residing in rural area. After controlling for the compounding variables, the result revealed that there is no significant effect of place of residence on childhood vaccination status by indicating AOR = .097, p = .736 (95% CI: .223, 1.134).

Table 19

Regression result for the place of residence (urban/rural)

	Simple Logistic Regression				Multivariate Logistic Regression			
			95% C.I. for EXP(B)				95% C.I. for EXP(B)	
Variable	OR	*p*	Lower	Upper	AOR	*p*	Lower	Upper
Place of Residence								
Urban	.451	.001	.281	.724	.503	.097	.223	1.134
For SLR: Cox and Snell R^2 = .006; NagelkerkeR^2 = .020; [(χ^2 (1, N = 1883) = 10.659, *p* = .001)]								

a. Variable(s) entered on step 1: Place of Residence

Note: OR:- Odd Ratio; AOR:- Adjusted Odd Ratio; *p*:- p – value; CI:- Confidence Interval; SLR:- Simple Logistic Regression.

Research Question 4

RQ4: Are there relationships between children's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto State, Nigeria?

Regarding sex of the respondents' children, the finding in Table 20 below shows that there is a significant relationship between sex and childhood vaccination status [(χ^2 (1, N = 1883) = 4.455, Phi = .050, *p* = .035)]. The descriptive statistics revealed that only 87 of the 1883 respondents' children, whether males or females, completed childhood vaccination. The proportion of Females (53.0%) who did not complete childhood vaccination are higher than that of Males (47.0%).

Table 20

Pearson Chi – Square of the relationship between sex and Childhood Vaccination Status

	Childhood Vaccination						
Independent Variable	Not Completed	Completed	Total	*df*	χ^2 – Stat.	Phi	Sig-χ^2
Sex				1	4.455	.050	.035
Male	845 (47.0%)	51 (58.6%)	896				
Female	951 (53.0%)	36 (41.1%)	987				
Total	1,796	87	1,883				

Hypothesis test for RQ4:

*Ho4*A: There is no relationship between children's sex and childhood vaccination status in Sokoto State, Nigeria.

*Ha4*A: There is a relationship between children's sex and childhood vaccination status in Sokoto State, Nigeria.

The finding in Table 21 revealed that sex is a significant predictor of childhood vaccination status. This also means that the result of both simple and multiple logistic regressions of sex based on odd ratio and adjusted odds ratio are statistically significant in relation to childhood vaccination status by indicating OR = .627, p = .036 (95% CI: .405, .971) and AOR = .566, p = .014 (95% CI: .359, .893) for male respondents. This indicated that male respondents have 60% chance of completing vaccination compared to female respondents. However, after controlling for the compounding variables in the model, the completion rate of male children was slightly reduced to about 56.6% compared to female participants. The simple logistic regression model is statistically

significant [(χ^2 (1, N = 1883) = 4.459, p = .035)] by indicating between 0.9% Cox & Snell R square (0.009 × 100) and 2.1% Nagelkerke R squared (0.021 × 100) of the variance in childhood vaccination status was explained by respondents' sex status; and correctly classified 96.5% of cases.

Table 21

Regression result for children's sex

	Simple Logistic Regression				Multivariate Logistic Regression			
			95% C.I. for EXP(B)				95% C.I. for EXP(B)	
Variable	OR	*p*	Lower	Upper	AOR	*p*	Lower	Upper
Sex								
Male	.627	.036	.405	.971	.566	.014	.359	.893
For SLR: Cox and Snell R^2 = .009; NagelkerkeR^2 = .021; [(χ^2 (1, N = 1883) = 4.459, p = .035)]								

a. Variable(s) entered on step 1: Sex

Note: OR:- Odd Ratio; AOR:- Adjusted Odd Ratio; *p*:- p – value; CI:- Confidence Interval; SLR:- Simple Logistic Regression.

The result in Table 22 below shows that there is a significant relationship between the birth order and childhood vaccination status, [(χ^2 (2, N = 1883) = 6.440, Cramer's V = .058, p = .040)]. The result of the descriptive analysis in the table below revealed that the non-completion rate of immunization is higher among the respondents with 1-4 children category (65.2%) followed by 5-8 children category (27.8%), and least among those with 9 children and above (7.0%). This shows that the birth order of a child could be a factor for determining completion of childhood vaccination even though there is no significant relationship between the two. The respondents with a smaller number of children completed childhood vaccination more than those with more children. The

completion rate of immunization as per recommended schedules decreased with increasing parity as shown in Table 22 below.

Table 22

Pearson Chi – Square of the relationship between birth order and Childhood Vaccination Status

	Childhood Vaccination						
Independent Variables	Not Completed	Completed	Total	*df*	χ^2 – Stat.	Cramer's V	Sig-χ^2
Birth Order				2	6.440	.058	.040
1 – 4 Children	1163 (65.2%)	78 (72.2%)	1,241				
5 – 8 Children	495 (27.8%)	20 (19.8%)	515				
9 Children and above	124 (7.0%)	3 (8.0%)	127				
Total	1,782	101	1,883				

*Ho4*A: There is no relationship between children's birth order and childhood vaccination status in Sokoto State, Nigeria.

*Ha4*A: There is a relationship between children's birth order and childhood vaccination status in Sokoto State, Nigeria.

Finally, simple logistic regression was used to examine the effect of birth order on childhood vaccination status. The finding in Table 23 below shows that children's birth order has a significant effect on childhood vaccination status among the respondents [(χ^2 (3, N = 1883) = 4.173, p = .041)] and able to correctly classify 96.5% of cases. The 1 – 4

children's birth order has a significant effect on childhood vaccination by indicating odd ratio of .482, p = .014 (95% CI: .269, .865) but 5 – 8 children category has no significant effect on childhood vaccination. This shows that the respondents in 1 – 4 children category have more than 50% higher childhood vaccination completion rate compared to those in 9 children and above. After controlling for compounding variables using Multiple Logistic Regression, the result indicated no significant effect of birth order on childhood vaccination status by showing AOR = .579, p = .089 (95% CI: .308, 1.088) for 1 – 4 children and AOR = 1.452, p = .466 (95% CI: .533, 3.955) for 5 – 8 children.

Table 23

Regression result for children's birth order

	Simple Logistic Regression				Multivariate Logistic Regression			
			95% C.I. for EXP(B)				95% C.I. for EXP(B)	
Variable	OR	*p*	Lower	Upper	AOR	*p*	Lower	Upper
Birth Order								
1 – 4 Children	.482	.014	.269	.865	.579	.089	.308	1.088
5 – 8 Children	.707	.464	.280	1.787	1.452	.466	.533	3.955
For SLR: Cox and Snell R^2 = .004; NagelkerkeR^2 = .012; [(χ^2 (3, N = 1883) = 4.173, p = .041)]								

a. Variable(s) entered on step 1: Birth Order

Note: OR:- Odd Ratio; AOR:- Adjusted Odd Ratio; *p*:- p-value; CI:- Confidence Interval; SLR:- Simple Logistic Regression.

Assessing the Final Model

The eight predicting variables influencing childhood vaccination status in Sokoto state, Nigeria were entered into the Multiple Logistic Regression model including parents' education level, occupation, family wealth index, ethnicity, religion, place of residence, and children's sex and birth order. Consequently, the multivariate logistic

regression model comprising of the eight categorical predicting variables is statistically significant [(χ^2 (17, N = 1883) = 80.096, p = .000)]. This revealed that the model was able to distinguish between participants who "have not completed =0" and those who "have completed = 1" their childhood vaccination based on all the predictor variables entered into the regression equation.

The result of the Multivariate Logistic Regression model indicated that between 4.2% Cox & Snell R square (0.042 × 100) and 13.3% Nagelkerke R squared (0.133 × 100) of the variance in childhood vaccination status was explained by predictor variables in the model; and correctly classified 96.2% of cases. The Omnibus Tests of Model Coefficients illustrates the multivariate logistic regression model fits the data (Hosmer and Lemeshow Test = (9.024, df = 8, p = .340).

Table 24

Predictive Model on the childhood vaccination Status for Multivariate Logistic Regression

Model Fits Information					Pseudo R – Square		
Model	-2 Log Likelihood	Chi-Square	*df*	*p*	Cox & Snell	Nagelkerke	Hosmer and Lemeshow Test
Final Model	624.821	80.096	17	.000	.042	.133	(9.024, *df* = 8, *p* = .340)

Conclusion

The results of the analysis showed that while some independent variables have significant effect on the childhood vaccination status, others were found to be non-

significant. In this regard, the independent variables including parents' educational level, occupation, family wealth index, ethnicity, and place of residence have significant effect on childhood vaccination status and therefore their null hypotheses were rejected. Conversely, the independent variables including religion, sex, and birth order do not have a significant effect on childhood vaccination status and so their null hypotheses were failed to be rejected.

Summary

In Chapter 4, I presented the study results showing whether there is a significant relationship or not between parent's socio-economic factors, ethnoreligious affiliation, place of residence, and children's sex and birth order and childhood vaccination status based on the country's immunization schedule. Descriptive analysis, Pearson chi-square, simple and multiple logistics regression analyses were employed to answer the research questions/hypotheses. The results showed that most of the predictive variables (parental education level, occupation, family wealth index, ethnicity, and place of residence) have a significant relationship with the outcome variable at a p-value less than 0.05.

In Chapter 5, the discussion of the findings of the study along with the limitations, conclusions, recommendations, and the implications of the findings for positive social change in the society and areas for further studies were presented.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

Immunization coverage remains low in Nigeria and most other resource-poor countries, leading to recurrent outbreaks of vaccine-preventable childhood diseases. This study examined the sociodemographic factors affecting childhood vaccination status in Sokoto state, Nigeria. The theoretical framework underlying the study is the SEM. The study's design provides evidence on the sociodemographic factors preventing the completion of childhood vaccination according to the recommended schedule leading to the sub-optimum immunization coverage in Sokoto state, Nigeria, for over a decade (NDHS, 2008; NDHS 2013; NDSH 2018). The study involved analyzing the 2018 NDHS survey dataset using SPSS version 22, followed by univariate, bivariate, and multivariate analyses. The final chapter (Chapter 5) captures the study results' interpretations, including recommendations for further study, implications for social change, and a conclusion.

In this study, I reviewed the relationship between the sociodemographic factors and childhood vaccination status in Sokoto state, Nigeria. Sokoto state's childhood vaccination status has been sub-optimum for over a decade. A couple of researchers have documented different factors both known and unknown as responsible for sub-optimum childhood vaccination status in Nigeria and other low resource countries (Antai, 2012; Fatiregun & Okoro, 2012; Hu et al., 2013; Kitamura et al., 2013; Lakew et al., 2015; Ophori et al., 2014). Although these referenced studies have identified several reasons for the sub-optimum childhood vaccination in other states and zones of Nigeria and other

countries, none have focused on Sokoto state. I explored the relationship between parents' socioeconomic factors (income, occupation, and educational level), ethnoreligious affiliation (religion and ethnicity), place of residence (urban or rural), and children's biological characteristics (sex and birth order) and childhood vaccination status.

In reviewing the relationship between the sociodemographic factors and childhood vaccination status in Sokoto state, Nigeria, I answered four research questions: (a) Are there relationships between parents' socioeconomic factors (educational level, occupation, and wealth index) and childhood vaccination status in Sokoto state, Nigeria, (b) Are there relationships between parents' ethnoreligious affiliation (tribe/ethnicity and religious belief) and childhood vaccination status in Sokoto state, Nigeria, (c) Are there relationships between parents' place of residence (rural/urban) and childhood vaccination status in Sokoto state, Nigeria, and (d) Are there relationships between a child's biological characteristics (sex and birth order) and childhood vaccination status in Sokoto state, Nigeria?

Interpretation of the Findings

The study addressed the relationship between the sociodemographic factors and childhood vaccination status in Sokoto state, Nigeria. Key highlights of the study findings showed that 66.4% of the respondents did not receive any form of education, while 61.6% are either in the Poorest or Poorer categories of the family wealth index. Sokoto state, the north-west zone, has the highest poverty level in Nigeria, with 40% living below the poverty line (National Bureau of Statistics, 2019). The study results show that

only 3.8% of the eligible children completed routine immunization based on the country's recommended vaccination schedule. This finding is like what Gidado et al. (2014) reported in a study conducted in the neighboring Zamfara state with similar demographics and socio-cultural features. They found that only 7.6% of eligible children completed childhood vaccination as per recommended schedule. This study's finding is consistent with WHO's (2015c) assertion that one out of every five children in Nigeria still misses routine immunizations.

Educational Level of Parents

The study's findings showed that parents' education level has a significant effect on childhood vaccination status. The childhood vaccination completion rate among the parents with primary education was almost twice that of those with no education. In contrast, children of parents who completed secondary education were three times higher than those with no education. The finding revealed that even parents with the basic primary education level had a higher completion rate of childhood vaccination than those without any form of education. The children of the parents with higher education level were 5.847 times more likely to be fully vaccinated than those with secondary schooling. Similarly, those with secondary education are 2.257 times more completely vaccinated than the children of uneducated parents. However, there was a slightly lower completion rate among mothers with higher education level than among those with secondary and primary level education, probably because those with higher education are working-class mothers with busy schedules. The finding agrees with the result from similar studies in other parts of Nigeria and other African countries that education influences the decision

to complete childhood vaccination (Kitamura et al., 2013; Lakew et al., 2015; Ophori et al., 2014). In studies from various parts of the world, the higher the level of parents' education, especially maternal education, the more the completion rate for childhood vaccination (Assahun et al., 2015; Ataguba et al., 2016; Forshaw et al., 2017). Debie and Taye (2014), in a study to assess the associated factors for full vaccination coverage among children aged 12–23 months in north-west Ethiopia, reported that educated mothers have better access to health information and services and are eventually aware of the benefits of vaccines and completing immunization according to the prescribed schedule. Studies conducted in different parts of Nigeria documented that female education improves child survival because of better knowledge to accept protective interventions, including childhood immunization, exclusive breastfeeding, better nutrition, and so on (Adedokun et al., 2017; Adeloye et al., 2017; Ataguba et al., 2016; Forshaw et al., 2017). In Ghana, Brugha et al. (1996) reported that a father's ability to write and read was significantly associated with a higher completion rate of childhood vaccination. Education improves the responsiveness to new ideas and services and provides better confidence in responding to health demands, including immunization services (Kazungu et al., 2015).

Additionally, knowledge may enhance the ability and willingness to cover distances in search of health services (Kazungu et al., 2015). In a study to assess the influence of parental education on children's use of public healthcare, including routine vaccines uptake in Spain, Mora and Trapero-Bertran (2018) reported that more educated parents use public health resources more frequently, including childhood vaccination

services. In Spain, the greater the parents' educational attainment, the higher their children's probability of completing their immunization as per the recommended schedule (Mora &Trapero-Bertran, 2018). Education gradient has continued to influence several preventive care measures in the public health system (Mora &Trapero-Bertran, 2018).

Globally, scholars have established a correlation between maternal education and the reduction in childhood mortality by accepting many interventions (Forshaw et al., 2017). Oleribe et al. (2017) also documented that several factors, including parents' education, determine the uptake of vaccines at different stages of commencement, continuation, and completion of the immunization. In Kenya, maternal educational levels significantly influenced immunization coverage because, with a higher level of education, mothers are more aware of the importance of immunization (Maina et al., 2013). Gidado et al. (2014) documented that in Zamfara state, Nigeria, maternal educational level helped improve childhood vaccination completion rate. Similarly, in Turkey, Ozer et al. (2018) demonstrated how maternal education significantly enhanced the uptake of the last doses of Hepatitis B and DPT immunizations for complete childhood protection. Forshaw et al. (2017) reviewed 37 papers and reported an increasing childhood immunization uptake with increasing maternal education. The odds of complete childhood vaccination are 2.3 times greater in children whose mothers received secondary or higher education than children whose mothers had no education. Therefore, improving maternal education also increases childhood vaccine uptake and coverage. The 2018 Nigerian NDHS report also showed that parents' educational level influenced the commencement and completion of

childhood vaccination (NPC & ICF Macro, 2018). Education, therefore, is a critical factor in social and economic development, as it creates more awareness leading to improvement in lifestyles and incomes of families (NPC & ICF Macro, 2018).

Occupation of Parents

Parents' occupation shows a significant influence on childhood vaccination status, where children of skilled and professional respondents achieved a higher completion rate than unskilled and unemployed parents. This finding supports similar ones from Kitamura et al. (2013) in Lao People's Democratic Republic and Danis et al. (2010) in Greece that the completion rate of childhood vaccination depends on the parents' (most especially mothers') employment status and other factors. In a study on paternal characteristics and childhood vaccination in the north-central part of Nigeria, the occupation of a child's parents, especially that of the mother, is an additional factor influencing vaccines' uptake (Adenike et al., 2017). Although most rural and urban respondents were housewives, those employed had significantly higher childhood vaccination completion rates than the unemployed (Adenike et al., 2017). In a study on the inequitable childhood immunization uptake in Nigeria, Antai (2009) argued that employed and working mothers had better childhood immunization coverage than unemployed or full-time housewives. Negussie et al. (2016), in a study in southern Ethiopia, reported that fully occupied and working mothers have been shown to accept and complete vaccination for their children much more than non-working mothers. Those parents employed by the government and other big corporations have social support, including health insurance, to address the out-of-pocket expenses that serve as barriers to

universal access to free immunization services in Nigeria and other resource-poor countries (Negussie et al., 2016).

Family Wealth Index

The family wealth status is another factor influencing the childhood vaccination. This study's findings showed that the family wealth index has a significant relationship with childhood vaccination completion rate. The poorest class of respondents recorded the highest proportion of not completed childhood vaccination (43.0%), followed by the poorer respondents (19.5%), while the richest class has the lowest proportion (10.5%). The higher the family wealth index, the higher the childhood immunization completion rate. These findings are consistent with a similar one from a study in Ethiopia, which showed that children from wealthier families had better childhood vaccination rates than those from more impoverished homes (Assahun et al., 2015). Antai (2009) reported that household wealth influences vaccination uptake in Nigeria. In Turkey, children from families with higher socioeconomic status have a higher chance of being fully vaccinated (Topuzoglu et al., 2005). Gram et al. (2019) also reported that being rich is associated with the likelihood of completion of immunization even in the core-North Nigeria with established health disparities due to most citizens' low wealth status. The prevalence of complete vaccination was considerably higher among the rich than the poor (Gram et al., 2019). In Norway, Feiring et al. (2014) demonstrated that the uptake of the human papilloma vaccine was influenced positively by family income level. Families with a higher wealth index had better completion rates of vaccination than others with lower incomes (Feiring et al., 2014). Lack of money is associated with poor health-seeking

behavior and deprivation of nutritious food for the children, leading to a failure to build a robust immune system (Gram et al., 2019). Additionally, children from low-income families are usually deprived of full immunization to fortify them against VPDs (Adedokun et al., 2017). The contrary finding was reported by Bbaale (2015) in a study conducted in Uganda that there was no association between parents' income level and the completion of childhood vaccination.

Religious Affiliation of Parents

The study's findings revealed that the respondents' religious background had no significant effect on immunization after controlling the covariates. This find is in contrast with the report of Ophori et al. (2014) in a study in Nigeria that religion greatly influences the acceptance of immunization, especially among the Muslims from the northern part of the country (Ophori et al., 2014). The finding is also not consistent with the one from The Netherlands, where religion influenced the decisions of parents/guardians towards accepting immunization among the orthodox Protestant minority groups (Ruijs et al., 2013). In India, Shrivastwa et al. (2015) found religion to be a determining factor in childhood vaccination, with Muslim children having a greater chance of being under-vaccinated than Hindus. In Nigeria, Antai (2009) analyzed 2003 demographic and health survey data to determine the role of religion in childhood vaccination and reported a significantly higher proportion of poorly immunized children among mothers who identified their religious affiliation as Muslims. Partially or non-immunized children were more likely to be from Muslim mothers than children whose mothers identified themselves as Christians (Antai, 2009). Babalola (2011) reported that

vaccine hesitancy amongst mothers in Northern Nigeria was related to their religious beliefs based on the rumors that vaccination contradicts the Islamic faith practices.

Tribe/Ethnicity of Parents

Ethnicity has a significant effect on childhood vaccination from the study. The completion rate of childhood vaccination of other tribes is three times higher than that of the Hausa/Fulani ethnic group. This finding is consistent with similar one from Antai (2011) in a study in the north-eastern part of Nigeria that there is a significant association between ethnicity and childhood vaccination completion. Children of Igbo mothers have 1.3 times the chance of receiving full vaccination than children of mothers from the Hausa/Fulani/Kanuri ethnic groups (Antai, 2011). Ataguba et al. (2016) argued that the ethnic difference in childhood vaccination completion rate reflects differences in social identity and socioeconomic position, attitudes of parents/caregivers, and health-seeking behavior. In Nigeria, an average Igbo ethnic tribe has more resources and higher economic power than the other tribes (NPC & ICF Macro, 2018). The Igbo children are twice more likely to be fully immunized than the Hausa children, who have low economic potential (Ataguba et al., 2016). Even after controlling for the confounding variables, this association remained significant. This signifies that ethnicity is an important factor in determining completion or otherwise of children's immunization schedules in Sokoto state, Nigeria. This finding is consistent with the one by Oyefara (2014) in Lagos State, Nigeria, on under-five children's immunization status, which showed that ethnic background and other personal characteristics are statistically associated with childhood vaccination status (Oyefara, 2014).

Place of Residence - Rural and Urban

There is a statistically significant relationship between place of residence and childhood vaccination status. The respondents residing in urban areas have a 50% higher immunization completion rate than those living in rural areas. However, after controlling for the compounding variables, the result revealed an absence of a significant effect of place of residence on childhood vaccination. This finding differs from the report of Nigeria's 2018 NDHS that there are differentials in the six zones. The children in the north-west zone with average vaccination coverage of 20%, for instance, are less likely to receive all basic vaccinations compared to children in the South East zone with 57% (NPC & ICF Macro, 2018). Additionally, states in the southern part of Nigeria were significantly related to better vaccination rates than the northern states (Adedokun et al., 2017; Oleribe et al., 2017). The odds of a child completing all vaccination according to the country's recommended schedule varied across urban and rural communities (Obanewa& Newell, 2020). The manifestation of urban-rural differentials in most resource-poor countries is related to access to healthcare services. The children in urban areas have easier accessibility to health facilities and services compared to those in the rural areas (Oleribe et al., 2017). The 2018 NDHS report showed that in Nigeria, immunization coverage differed slightly by the type of residence, with 44% of children in urban communities being fully vaccinated than only 23% in rural areas (NPC & ICF Macro, 2018).

Children's Biological Characteristics - Sex and Birth Order

The sex of the respondents' children is a significant predictor of childhood vaccination status. The male children of the respondents have a 60% higher immunization completion rate than the females. However, after controlling for the compounding variables in the model, the completion rate of male children was slightly reduced to .566 times compared to female participants. The study's finding is consistent with the report from Kiros and White (2004) that immunization uptake also varied by the sex of the child, with male children being more likely than females to receive complete doses of vaccines.

The birth order of children has a significant effect on their vaccination status. The 1 – 4 children's birth order has a significant effect on childhood vaccination, while the 5 – 8 children category has no significant effect on childhood vaccination. The respondents in the 1 – 4 children category have more than 50% higher childhood vaccination completion rates than those in 9 children and above. However, after controlling for compounding variables, the result showed no significant effect of birth order on childhood vaccination status. Therefore, birth order has no significant relationship with childhood vaccination status. The study finding is not consistent with report from Kitamura et al. (2013) in a study on factors affecting childhood immunization in the Lao People's Democratic Republic which revealed that children's biological characteristics including being a male child and being first or second born in a family significantly increase the chance of being vaccinated. The finding also contrasts the one from Antai

(2011) that children in Nigeria of the fifth and above birth order have a significantly lower likelihood of being fully vaccinated than second to fourth birth orders.

Interpretation of the Findings in the Context of the Theoretical Framework

The findings of this study support the social ecological model by establishing how key independent variables are mapped to the different levels of the SEM including

a) Individual factors or Microsystem: Education, Sex, Birth Order

b) Relationship or mesosystem: Religion, Cultural affiliation

c) Community or exosystem: Place of Residence, and

d) Society or macrosystem: Religion, Residence.

The analysis supports previous literature by showing the relationship between cultural, religious, and environmental factors influencing some parents to refuse vaccines for their children leading to low immunization coverage and herd immunity (Murele et al., 2014) Within the context of strengthening immunization services, all layers of children's environment do influence completion or lack of completion of childhood vaccination. In line with the SEM, parents' socioeconomic status (educational level, occupation, and family wealth index), tribe/ethnicity, and the sex of the child have a significant relationship with completion of childhood vaccination. The analysis of the secondary dataset by various authors showed that individual factors like sex and birth order, relationships like religion or cultural affiliation, community factors like place of residence, and societal factors like religion all have a significant relationship with the completion of childhood vaccination. Within the context of strengthening immunization services in Sokoto state, all the child's environment layers could influence completion or

lack of completion of childhood vaccination. In Sokoto and other states in the north, for instance, cultural and environmental factors have influenced some parents to refuse vaccines for their children leading to low immunization coverage and herd immunity with attendant effect of frequent outbreaks of vaccine-preventable diseases including measles, tuberculosis, hepatitis, tetanus, and poliomyelitis (Murele et al., 2014).

From the study, relationship factors, including parents' socioeconomic level (education, occupation, and family wealth index) have a significant relationship with the completion of childhood vaccination. This finding supports the role of relationship factors of the SEM towards improving uptake or acceptance of public health interventions including childhood vaccination status. Improvement in the socioeconomic status of parents in the state is likely to boost childhood vaccination status since the multivariate analysis results showed that families with higher wealth index had better completion rate. Thus, improving the relationship and environmental factors of a child including parents' socioeconomic status may improve vaccination status in Sokoto state since the result showed children of the richest class have almost four times higher childhood vaccination completion rate than the respondents in the poorest class.

Limitations of the Study

The study sample population was limited to Sokoto State and not representative of the entire Nigerian population. Therefore, the findings can only be generalized to Sokoto state because there might be other factors influencing childhood vaccination status in other parts of the country which might have peculiar socio-cultural characteristics. Although DHS studies are common globally and the dataset reliable and trustworthy by

researchers, the use of secondary datasets usually has some limitations, including missing key variables since they were not collected for any study. Using the secondary dataset, it is generally challenging to control for confounders identified by previous researchers, including place of residence, cultural affiliations, and sex. During the primary data collection stage, it is possible that such key variables were missed (Smith et al., 2011). A prospective study using primary data could establish causality rather than a retrospective study using secondary data to establish the relationship between the socio-demographic factors and childhood vaccination status in Sokoto. One of the fundamental observations of this study was the recognition that the dependent variable in the study (childhood vaccination status) was determined mainly from parents' recall which was invalidated. Most parents' in Sokoto reported completion of routine vaccination as per schedules from memory with the attendant effect of recall bias leading to perhaps over-or under-estimation of the number of vaccine doses received.

Recommendations

During the collection of the primary data for the 2018 NDHS, there might have been data omission on some essential factors. Additionally, there is the likelihood that the study did not exhaustively explore other critical factors that influence childhood vaccination status in Sokoto state. In this case, the recommendation is to conduct both a quantitative and qualitative study where the researcher is personally involved in collecting the data. Although conducting a quantitative and qualitative study is usually expensive and time-consuming, the result is likely to yield better insight into the root causes of the decade-long sub-optimum vaccination status in Sokoto state. At both the

national and sub-national levels, a couple of hospital-based studies using small sample sizes have been conducted with only a few community-based studies. However, none was done in Sokoto state from the literature reviewed, hence the need to conduct similar study at the community level using large sample sizes to fill the gaps in the literature. Since the study established a significant relationship between parents' educational level, occupation, family wealth index, ethnicity, sex, and childhood vaccination status, the findings could be helpful to policymakers and stakeholders in planning and implementing context-specific interventions.

The policymakers and stakeholders could use the findings to plan and implement some interventions supporting access to quality education and health care services through affordable health insurance schemes, and the need to improve family incomes to cushion the effect of high out-of-pocket expenses in Sokoto state, Nigeria. The government, especially at the lower or district level (local government areas), could find the study's result helpful to strengthen social services and improve parents' health-seeking behavior. The academic community could benefit from the findings because it focused specifically on Sokoto state which consistently recorded the lowest childhood vaccination coverage in the country from the last three surveys conducted in 2003, 2015, and 2018. When properly implemented, the recommendations could help improve access to healthcare services, including childhood vaccinations, to address the burden of childhood morbidity and mortality in Sokoto and other parts of Nigeria and beyond. The policymakers, government bureaucrats, and other stakeholders could use the study's

empirical evidence for informed decisions affecting the vulnerable populations of children and women.

Implications for Social Change

The contributing factors to the decade-long low childhood vaccination status of Sokoto state have not been sufficiently explored. The study could be described as the first to explore the sociodemographic factors influencing childhood vaccination in Sokoto state through a retrospective cross-sectional analysis of 2018 NDHS secondary datasets. This body of research will contribute to identifying some sociodemographic factors which may influence childhood vaccination in Sokoto state, Nigeria. This study is important to social change as Sokoto remains one of the states in the country with frequent outbreaks of vaccine-preventable diseases. Given the peculiarity of Sokoto state as a predominantly Muslim community with some resistance against vaccines for fear of depopulation by the western powers, the findings from this study may provide additional information for planning, implementation, and evaluation of interventions to improve the uptake of vaccination services.

Efforts to improve the completion of childhood vaccination at the community level must include innovative ideas generated together with the active participation of the communities for sustainability to address the sociodemographic factors influencing the low childhood vaccination rate. Partners in these efforts should include Nigeria‘s National Primary Health Care Development Agency, the Federal Ministry of Health, Sokoto State Primary Health Care Agencies, other government partners, civil society organizations, local community leaders (traditional, religious, youths, women groups, and

so on), and bilateral and multilateral partners in health in Sokoto state and Nigeria. If a large proportion of children in Sokoto and other neighboring states remain un- or poorly vaccinated against childhood diseases, the consequences of frequent outbreaks of vaccine-preventable diseases will continue to be high childhood morbidity and mortality in the state. The potential for positive social change is the need for public health interventions to target children of uneducated parents and poor families from the Hausa/Fulani Muslim communities from different occupations residing in rural areas in Sokoto state to enhance childhood vaccination status.

Conclusion

Since the 19th century, life expectancy at birth has consistently increased chiefly due to the improvement in families' socioeconomic status and innovative public health measures, including immunization, sanitation, and nutrition (World Health Assembly, 2018). Currently, socioeconomic, political, and cultural factors are just a few of the forces driving changes in the global burden of diseases (Ghebreyesus, 2017). However, Nigeria and other low-resourced countries continue to experience frequent outbreaks of vaccine-preventable diseases. Sokoto State in the northwestern part of the country has suffered from a low childhood vaccination completion rate for over a decade. In the 2018 NDHS, only 5% of children aged 12-23 months in Sokoto state had full childhood vaccination. The factors associated with the low childhood vaccination status of the state have not been explored. This study examined the factors related to the low performance in vaccination using a retrospective cross-sectional dataset analysis from 2018 NDHS.

The findings from this study revealed a significant relationship between parents' educational level, occupation, family wealth index, ethnic background, and children's birth order, and childhood vaccination status in Sokoto state, Nigeria. To date, immunization remains the most cost-effective public health intervention to curb the incidences of childhood morbidity, mortality, and disability not only in Sokoto and other parts of Nigeria but across the world. As other countries have entirely adopted vaccination for their eligible children, Sokoto citizens need to do the same and step up vaccine uptake for better child survival indices. Although Sokoto state still records only a 5 percent completion rate of childhood vaccination and over 50% of the parents have received no formal education, the key parental and child-related factors associated with sub-optimum immunization coverage are preventable with the right political will, adequate funding, health education and awareness creation of parents and all stakeholders. There is the need to develop key messaging in local dialects targeting specific groups in Sokoto state rather than generic social mobilization messages. It is critical for parents to take responsibility for the health and well-being of their children especially on the completion of routine immunization as per the recommended schedules.

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