2021

# Demographic and Socioeconomic Determinants of Lassa Fever in Edo State, Nigeria

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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## Abstract

Lassa fever is a viral hemorrhagic fever caused by the Lassa virus and associated with significant morbidity and mortality. Yearly outbreaks of the disease occur in Edo State, Nigeria. The purpose of this study was to examine the demographic and socioeconomic factors that can influence transmission of the disease. The Commission on Social Determinants of Health conceptual framework was used in this research study. This framework describes the relationship between structural and intermediary factors and how they determine health outcomes. To answer the research question of how demographic and socioeconomic factors influence Lassa fever transmission in Edo State, a cross-sectional study was designed. After IRB approval, a questionnaire was used to collect data from sampled residents in six selected Local Government Areas in Edo State. Using SPSS, the relationships between independent variables (demographic and socioeconomic factors) and Lassa fever transmission were tested with chi square and logistic regression. The key findings in this study were that urban residence, occupation, monthly household income, poor housing condition and ethnic group were significantly associated with Lassa fever transmission. Recommendations from these findings include the consideration of these factors in the design and implementation of strategies for the control of the disease by government and partner organizations. The findings of this study can contribute to social change by providing empirical evidence to enhance the targets of advocacy and risk communication for Lassa fever control.

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# Dedication

I dedicate this work to God Almighty for granting me strength to go on whenever I felt like giving up; to my husband, Jonathan Ireye, for his unflinching support; and to my children for their understanding.

# Acknowledgments

I wish to acknowledge the great support I got from my Chair/Mentor (Dr. David Anderson), 2nd Member (Dr. Stephanie Hsieh), URR (Dr. JaMuir M. Robinson), and my Student Success Advising Specialist (Jill Kaspszak, MBA). They were amazing in guiding me through this long research journey. I also wish to thank Walden IRB for its careful assessment of my research proposal and for ensuring that the work was done in accordance with best ethical standards.

The Edo State Ministry of Health and the authorities of the study local government areas (LGAs) were very cooperative in the course of my research work. Thank you very much. Thank you, Dr. Alphonsus Aigbiremolen and Mrs. Grace Ireotoi, for your assistance and encouragement. I will not also fail to acknowledge Dan Oyaole for inspiring me to start this program. God bless you.

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# Chapter 1: Introduction to the Study

Developing countries are burdened with infectious diseases such as malaria, cholera, typhoid, acute respiratory illness, and viral hemorrhagic fevers, among others. Among some West African countries—including Nigeria, Lassa fever is a prominent disease that has contributed significantly to morbidity and mortality in the region (Azeez-Akande, 2016; Kerneis et al., 2009). In Nigeria, the prevalence of Lassa fever is highest in some southern states including Edo State (Ochei et al., 2014; Ogoina, 2013). This study was conducted to understand the factors associated with the transmission of this disease in Edo State.

Lassa fever, like many infectious diseases, has both epidemiological and socioeconomic consequences (Asogun, et al., 2016; Boutayeb, 2010; Ogoina, 2013). Reduction of the disease burden can be enhanced by better understanding of possible determinants of the transmission of the infection. Effective control of Lassa fever can free up individual, community, and government resources being consumed or put in use as a result of the morbidity associated with the disease.

This chapter is broken into various sections. The Background section provides discussion of some research literature related to the scope of the study and highlights the gap in knowledge that this study intends to fill with respect to Lassa fever transmission in an endemic area. In the Problem Statement section, the problems of Lassa fever outbreaks are highlighted. In addition, the relevance and significance of the problem of Lassa fever in the light of current evidence is discussed. Following that section, the Purpose of the Study and the study approach to achieve it is stated. There are three

research questions that were addressed in this work. These questions and their accompanying hypotheses are clearly outlined in the section Research Questions and Hypotheses. Next, the conceptual framework that embraces the determinants of disease that were explored in this study is briefly discussed, whereas the section on the nature of study states the rationale for the study design and briefly describes the study variables and study methodology. Other sections in this chapter include Assumptions, Scope and Delimitations, Limitations of the Study, and Significance, including positive social change.

## Background

Lassa fever is an acute viral hemorrhagic illness caused by Lassa virus (LASV), a member of the arenavirus family of viruses (Thairu & Egenti, 2015). Humans usually become infected with LASV through exposure to food or household items contaminated with urine or feces of infected Mastomys rats (World Health Organization (WHO), 2018). Early clinical manifestations are often indistinguishable from those of many other febrile illnesses, making clinical diagnosis difficult (Bausch et al., 2000). The infection is endemic in West African countries and causes about half a million infections and about 5,000 deaths annually (Azeez-Akande, 2016). Outbreaks of the disease occurs in Nigeria, Liberia, Sierra Leone, Guinea, and Central African Republic, but it is believed that human infections also exist in Democratic Republic of Congo, Mali, and Senegal (Adewuyi et al., 2009; Ogbu et al., 2007; Saez et al., 2018). Its primary animal host is the multi-mammate rat (*Mastomys natalensis*), a rodent indigenous to most of Sub-Saharan

African. The virus is transmitted to man by contact with the vector rodent, making it a zoonotic disease (Azeez-Akande, 2016; Houlihan & Behrens, 1986).

Lassa fever was first reported in Lassa village in Borno State of Nigeria in 1969. But today, it has been reported in more than 18 of the 36 states in Nigeria (Nigeria Centre for Disease Control [NCDC], 2019a; Yun & Walker, 2012). In the first reported case of Lassa fever, a nurse was the index case. From the report, the nurse seemed to have acquired the infection from a patient residing in the town of Lassa and being managed for an obstetric condition. She died approximately 1 week after the onset of symptoms (Bond et al., 2013). Thus, the previously unknown disease was called Lassa fever. In the period following the infection of the first nurse, two more cases of the infection and one death were reported among other nurses who attended to the index case (Bond et al., 2013).

In recent times, the case fatality rate (CFR) for Lassa fever during outbreaks has been as high as 27% involving persons of all age groups both in urban and rural communities (NCDC, 2019b). There have also been reports of Lassa fever infection and mortalities among health care workers who were exposed while attending to cases of Lassa fever and these occurrences have been linked to poor infection prevention and control practices (Dan-Nwafor, Furuse, et al., 2019; Dan-Nwafor, Ipadeola, et al., 2019). In 2018 alone, 633 cases of Lassa fever were confirmed from 21 states across Nigeria (NCDC, 2018). The number of confirmed cases increased to 810 from 23 states in 2019 and a CFR of 20.6% was reported (NCDC, 2019a). The yearly and, in recent times, worsening outbreaks of Lassa fever in many states in Nigeria including Edo State suggests that there are still factors yet to be understood in the transmission of the

infection. The findings of this study are meant to contribute to understanding these factors.

## Problem Statement

Outbreaks of Lassa fever, also known as Lassa hemorrhagic fever (LHF), occur almost on a yearly basis in Nigeria with severe clinical manifestations and high CFRs (Ehichioya et al., 2012; NCDC, 2018). The disease is associated with vector breeding, poor environmental sanitation, and poor food handling practices (Ochei et al., 2014; Tobin et al., 2015). *M. natalensis*, a multi-mammate rodent that breeds primarily in bushes surrounding houses located in endemic communities, is the major vector known to transmit LASV to humans (Ogoina, 2013).

Infected rodents remain carriers throughout their life and do not show clinical symptoms but pass on the virus through droppings, urine, saliva, respiratory secretion and exposed blood vessels through micro- or macro-trauma (Ogbu et al., 2007; Yun & Walker, 2012). It may be safely assumed that infected rodents do not invade homes with the intention to shed the virus or infect occupants, but they move around in search of food, shelter, and breeding spaces. Thus, any housing condition that provides opportunities for these rodents' needs to be met promotes transmission of the LASV.

Edo State is one of the foremost endemic states for Lassa fever in Nigeria (Asogun et al., 2010). It had the highest number of cases in the country in the 2018 outbreak, recording 279 cases (44.1%) out of 633 confirmed cases in the entire country (NCDC, 2019b).

As depicted by data from recent outbreaks, more than a quarter of cases of Lassa fever are at risk of death for all age groups (NCDC, 2019b; WHO, 2016). Therefore, the adverse implications of the disease are considered significant. Consequently, a lot of resources are expended yearly to control the disease with resultant effects on households and communities.

Environmental and ecological factors have been identified in previous studies as important considerations in understanding the endemicity and transmission of Lassa fever (Aigbiremolen et al., 2017; Ochei et al., 2014) However, the importance of demographic and socioeconomic factors involved in the transmission of Lassa fever remains to be adequately explored. Demographic factors under consideration in the current study include age, gender, marital status, and residence (rural or urban), whereas the socioeconomic factors are occupation, employment status, education, income, access to healthcare services, housing, and ethnicity. Some of these factors are linked to environmental and ecological factors (Bonner et al., 2007; Gbakeji et al., 2016; Muanya, 2016). I studied these factors as they relate to the transmission of Lassa fever in endemic communities in Edo State.

## Purpose of the Study

The purpose of this dissertation was to investigate the various demographic and socioeconomic factors that influence the occurrence and transmission of Lassa fever in Edo State using a quantitative approach, and to provide evidence for the consideration of these factors in the control of Lassa fever.

The specific objectives of this study were

- to identify demographic determinants of Lassa fever transmission in endemic communities in Edo State,
- to determine socioeconomic factors that significantly influences the transmission of Lassa fever in Edo State, and
- to determine the relationship between area of residence (residence versus urban) and the reported mortality of Lassa fever in Edo State.

## Research Questions and Hypotheses

1. What are the significant demographic determinants (age, gender, marital status, type of residence, and ethnicity) of Lassa fever transmission in endemic communities in Edo State?

$H_0$1: There are no significant demographic factors implicated in the transmission of Lassa fever in endemic communities in Edo State.

$H_1$1: There are significant demographic factors implicated in the transmission of Lassa fever in endemic communities in Edo State.

2. What are the significant socioeconomic factors (occupation, employment status, educational attainment, income level, availability of healthcare services, and housing) that determine the transmission of Lassa fever in Edo State?

$H_0$2: Socioeconomic factors are not significant in the transmission of Lassa fever in endemic communities in Edo State.

$H_1$2: Socioeconomic factors are significant factors in the transmission of Lassa fever in endemic communities in Edo State.

3. Is there an association between residence and mortality of Lassa fever in Edo State?

$H_0$3: There is no association between residence and mortality of Lassa fever in Edo State.

$H_1$3): There is an association between residence and mortality of Lassa fever in Edo State.

## Conceptual Framework

The Commission on Social Determinants of Health (CSDH) conceptual framework was used in this research work (Solar & Irwin, 2010). The framework has been applied by researchers in understanding the role of social determinants in health and health inequalities (Jayasinghe, 2015; Målqvist et al., 2012; Wong et al., 2017; Zaboli et al., 2014). The CSDH conceptual framework has two major aspects. These are the structural determinants and intermediary determinants of health.

The structural determinants include socioeconomic and political context on the one hand and socioeconomic position on the other hand. The socioeconomic and political context includes social systems such as the educational system and labor market; cultural factors such as ethnicity and the political systems which relate to the structure of governance and policy formulation and implementation. Socioeconomic positions are based on institutional mechanisms that influence stratifications based on income, wealth, educational level, occupation, gender, and other related dimensions (Jayasinghe, 2015). Socioeconomic positions of individuals and households influence access to resources necessary for lifestyle that engender disease prevention and promote healthy living.

Intermediary determinants link social determinants of health to health-related behaviors and physiological factors. This link represents a vulnerability to health-compromising conditions due to socioeconomic factors including poverty.

Poverty and the consequences of poverty such as poor nutrition, air pollution and poor sanitation and inadequate access to education and health care services are reported to account for most of the disease burden in developing countries (Stevens, 2004). The demographic and socioeconomic determinants of Lassa fever such as age, gender, employment status, rural-urban differences, poor housing, poor sanitation, income, and occupation amongst others can be considered within the framework proposed by CSDH. The relationship between these factors and transmission of Lassa fever was the focus of this dissertation and are further discussed in Chapter 2 of this work.

## Nature of the Study

A quantitative approach was used in this dissertation, being a variable-centered study. The study was done using a cross-sectional design. A cross-sectional study design is useful in studying associations between variables (Habib et al., 2014; Mann, 2003). The dependent variable in this study was the transmission of Lassa fever in the community while the independent variables were demographic and socioeconomic factors that may influence transmission of LASV from rodents to humans or from human to human. This study involved the use of questionnaires to obtain relevant information from sampled respondents in selected communities in Edo State after obtaining approval from Walden's Institutional Review Board (IRB). A multi-stage sampling technique was used to select respondents from communities in the State including communities where

there have been reports of confirmed Lassa fever cases in the last two years preceding this study. The information gathered was analyzed using both descriptive and inferential statistical methods and the results were used to answer the research questions.

## Definitions

*Transmission of Lassa fever*: Transmission of Lassa fever is the condition in which the LASV that is found in the vector (commonly *M. natalensis*) is spread to human population or spread from an infected person to another. Lassa fever transmission is described as primary (i.e., spread from rodents to man) or secondary (i.e., spread from humans to humans) transmission (Hamblion et al., 2018; Tobin et al., 2013). Occurrence of confirmed cases of Lassa fever is the evidence of transmission in the affected community or area.

*Demographic factors*: Demographic factors are characteristics that relate to the structure and growth of populations. The basic demographic descriptions commonly used include age, gender, marital status, and residence but may also have an extended meaning that includes socio-demographic factors that are related to health status and outcomes (Degl'Innocenti et al., 2005; Tarsi & Tuff, 2012). However, in this study, the demographic factors that were considered were limited to age, gender, marital status, type of residence, and ethnicity.

*Socioeconomic factors*: Socioeconomic factors are characteristics of persons that describe their social and financial standing. They are a combination of conditions that define the status of the individual in terms of his or her access to resources that are needed to guarantee well-being. In this study, the socioeconomic factors studied were

occupation, employment status, educational attainment, income level, availability of healthcare services, and housing. These factors are generally considered as important factors in health outcomes (Blane, 1995; Dean & Fenton, 2013).

## Assumptions

A few assumptions were made in the course of carrying out this study. First, it was assumed that the potential respondents would cooperate with the research process as to allow me to visit their personal homes or encroach into their personal schedules to administer the study questionnaire. The contents of the consent form were discussed with potential participants only after they had indicated their interest to participate in the research. Closely related to this was the assumption that the respondents provided accurate and honest responses to the questions that were asked.

## Scope and Delimitations

This study was carried out in selected communities within Edo State. The focus of the investigation was limited to studying demographic and socioeconomic characteristics of the study population. These characteristics are captured in the CSDH framework which was adopted as the conceptual framework for this research. Other possible determinants of Lassa fever such as presence of vectors and climatic factors were beyond the scope of this work.

In selecting and grading communities with reported cases of Lassa fever, all age groups were considered. This was because all household members, children and adults alike, may be exposed to conditions that promote LASV infection. However, the study questionnaire was administered to only adult respondents (persons older than 18 years).

The questionnaire's validity was addressed by conducting a pilot study in Esan Central LGA, a non-selected LGA with similar sociocultural characteristics to the selected LGAs. The outcome of this research can be generalized to other Lassa fever endemic states in Nigeria and may further be generalized to other countries with regular outbreaks of the disease in the West African region.

## Limitations of the Study

The procedure for this study required identifying persons who have been infected with Lassa fever in the past and visiting their households and/or communities. After obtaining IRB approval for the research, I identified LGAs, communities, and settlements that met the selection criteria by extracting information from the Edo State Lassa Fever Surveillance Register. Some of the respondents were previously diagnosed of Lassa fever and felt somewhat reluctant to participate in the study due to possible stigma, but after I explained the purpose of the study and assured them of adequate confidentiality, most of them cooperated. However, some individuals (4% of those recruited) declined participation and were consequently excluded from the study.

Another limitation of the study was the challenges posed by the COVID-19 pandemic and the associated restrictions in movement and meetings. The restrictions prevented visits to the homes of respondents and required inviting potential respondents to designated meeting points. Such meeting schedules were largely at the convenience of the respondents. However, with adherence to COVID-19 prevention protocols such as social distancing, hand hygiene and use of facemasks, and agreement on alternative

meeting schedules, an adequate number of respondents (336 persons) participated in the study.

## Significance

Disease control efforts for Lassa fever require strategies based on empirical evidence. The multidimensional approach involves environmental, ecological, socioeconomic, and promotional as well as curative interventions. Rural–urban differences, housing, poverty, and hygiene problems need to be taken into consideration in implementing sustainable solutions to the Lassa fever burden in Edo State. This study has provided the required information in this direction. Also, information obtained through this research effort will be made available to policy formulators and program designers tasked with dealing with communicable diseases.

This study has contributed to positive social change in that it has provided information to support evidence-based advocacy and social mobilization, which are useful for encouraging behavior change among individuals, households, and entire communities (Davis et al., 2017; Kaare et al., 2007; Tobin et al., 2015). In addition, health promotion messages will become enriched and more population-focused in the light of a better understanding of the demographic and socioeconomic determinants of Lassa fever in the study area as demonstrated in this research.

## Summary

LASV, the causative agent of Lassa fever, is carried by a rodent vector that has been found mostly to be the multi-mammate rat, *M. natalensis*. Lassa fever is transmitted primarily from vector rodents to man and, secondarily, from an infected person to others.

There are observed differences in the prevalence of the disease from community to community. The purpose of this study was to examine the demographic and socioeconomic factors that may be associated with the disease in Edo State using a quantitative approach. This study has contributed to the wealth of empirical evidence relevant to the control of Lassa fever by proving a better understanding of the determinants of disease transmission. In the next chapter, I shall review existing literature that relate to basic concepts and key variables in this study.

# Chapter 2: Literature Review

Lassa fever is a viral hemorrhagic fever and a disease of public health concern. It is an acute febrile illness caused by the LASV and manifests with bleeding and death in severe cases (Thairu & Egenti, 2015; Yun & Walker, 2012). The purpose of this cross-sectional study was to assess the demographic and socioeconomic determinants of the transmission of Lassa fever in Edo State. The outcome of this study is expected to be a contribution of evidence to the knowledge of variables that influence the transmission of the disease and how to control it effectively in the study population and elsewhere.

In recent times, the number of reported cases of Lassa fever in Edo State remained almost always the highest in Nigeria (NCDC, 2019a, 2019b; Tobin et al., 2015). The outbreaks often result in a strain on the already fragile healthcare system and expose health care workers to risks of nosocomial infections (Dan-Nwafor, Ipadeola, et al., 2019; Ireye et al., 2019). In addition to the associated morbidity, the disease disrupts socioeconomic activities of those infected when they can no longer perform their usual activities and have to remain in isolation while undergoing treatment (Asogun et al., 2016).

The sections in this chapter include information on literature search strategy, conceptual framework, and details of the review of available literature on key concepts and variables relevant to the research subject. The essential elements of the CSDH (Solar & Irwin, 2010) and how they relate to this study are described in the section on conceptual framework. In the section on key variables and concepts related to the study, I

discuss basic information on LASV and the concept of Lassa fever transmission, as well as existing literature on demographic and socioeconomic factors in Lassa fever.

## Literature Search Strategy

I conducted literature searches in both online and off-line sources. Online sources included publication/data archives such as PubMed, Bio Med Central, Springer and Google Scholar as well as in the Walden Library. The literature search in these databases was restricted mostly to articles published in the last 10 years. I also searched using search engines in the open internet such as Bing, Google, and MSN. In these online sources, the search words and phrases were *Lassa fever*, *transmission of Lassa fever*, *Lassa fever in Edo State*, *factors in Lassa fever*, *determinants of Lassa fever*, *determinants of health*, *demographic factors and Lassa fever*, *socioeconomic factors in Lassa fever*, *Lassa fever outbreaks*, *Lassa vectors*, and *pathology of Lassa fever*, among others.

I also sourced literature from some local libraries in educational and health institutions in Edo State, Nigeria. These included the College of Medicine, Ambrose Alli University, Ekpoma; Department of Community Medicine, Irrua Specialist Teaching Hospital, Irrua and Cedar Center for Health and Development, Ekpoma. Materials from the federal and state ministries of health as well as their parastatals were consulted as part of the literature review process. Researchers who have worked on the subject of Lassa fever in these institutions also provided some guidance on where to look for relevant literature.

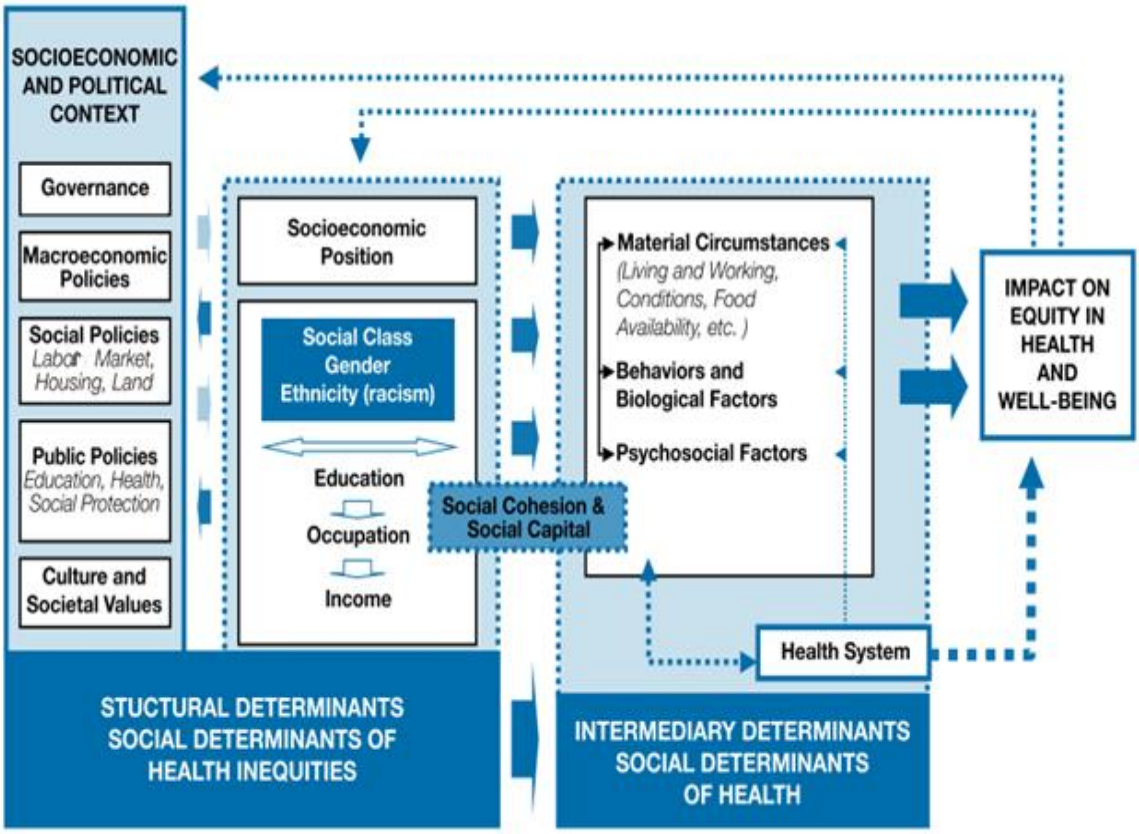
## Conceptual Framework

The CSDH conceptual framework (Solar & Irwin, 2010) was used in this research work. The CSDH framework derives primarily from the earlier concept of social determinant of health inequalities (SDHI) promoted in the 19th century (Jayasinghe, 2015; Solar & Irwin, 2010). The concept is used to denote the contexts, social norms, social structures, and their determinants as well as how they relate to health outcomes (Jayasinghe, 2015). It also proposes that health inequalities are generated from three main paths: social selection, social causation, and a life course perspective. Factors such as maternal malnutrition during fetal period, childhood exposure to poor educational facilities, occupation, income levels, and socioeconomic position determine responses to diseases and eventual health outcomes (Jayasinghe, 2015).

The CSDH conceptual framework has two major aspects: structural determinants and intermediary determinants of health (Friel & Marmot, 2011; Solar & Irwin, 2010). Structural determinants include socioeconomic and political context on the one hand, and socioeconomic positions on the other hand. It is the interplay of these two subcomponents of structural determinants that feed the intermediary determinants. In the framework, factors in the socioeconomic and political context include governance, sociocultural values and policies that influence housing, labor, and education, whereas socioeconomic position consists of social class, gender, ethnicity, education, income, and occupation (Solar & Irwin, 2010).

**Figure 1**

*Commission on Social Determinants of Health Conceptual Framework*




*Note*. From *A Conceptual Framework for Action on the Social Determinants of health*, by O. Solar & A. Irwin, 2010, World Health Organization (https://www.who.int/sdhconference/resources/ConceptualframeworkforactiononSDH_eng.pdf). Copyright 2010 by World Health Organization.

Embedded within intermediary determinants are factors such as material circumstances (living and working conditions, and food availability), behavioral, psychological and biological factors (Zaboli et al., 2014). Intermediary determinants of health eventually impact on health equity and well-being of individuals, households and communities (Solar & Irwin, 2010; Zaboli et al., 2014). Though the factors represented in the CSDH framework are relevant in all settings, it is particularly important to give it a strong consideration when examining an infectious disease like Lassa fever that has been recording repeated outbreaks in many communities in Edo State which is in a developing country. This is because culture, socioeconomic status, income levels, employment and rural and urban residence are key determinants of health inequality or otherwise in developing countries (Zaboli et al., 2014).

The framework has been applied by researchers in understanding the role of social determinants in health and the factors that underlie health inequalities (Jayasinghe, 2015; Målqvist et al., 2012; Wong et al., 2017; Zaboli et al., 2014). Jayasinghe (2015) posited that social determinants of health can be visualized from a systems science perspective. According to Jayashinghe, determinants of health such as educational attainment, economic wellbeing, and social status are component parts of standard of living, and patterns of health inequalities are interrelated with patterns of health outcomes. He concluded by asserting that different combinations of various determinant factors can give rise to widely variant outcomes depending on the contextual environment.

In a study done in Vietnam to map the causes of maternal and child health inequality, the CSDH framework was applied by Målqvist et al. (2012). Demographic

and socioeconomic factors were explored as they relate to maternal and child health outcomes. In the report, ethnicity was a major demographic factor that influenced health outcomes and ethnic minority was associated with poverty, higher fertility rates and lower utilization of contraceptives. The authors also noted that poor socioeconomic status is a vulnerability factor in illness and disease.

The CSDH framework was also applied in a study on mental health of African asylum-seekers and refugees in Hong Kong (Wong et al., 2017). The authors used a cross-sectional design to survey socio- demographics, health status, health behaviors, and social experiences of 374 participants. They reported that age, living with family, and poor access to healthcare services were significant determinants of depression among African asylum seekers and refugees in Hong Kong (Wong et al., 2017). Socioeconomic conditions such as education, employment, and housing were the most identified determinants of health inequalities in a study that applied the CSDH framework in prioritizing determinants of health in Iran (Zaboli et al., 2014). The authors observed that the identified factors were mostly adjustable and that the findings may be applicable to other developing countries.

Control of infectious diseases like HIV/AIDs, tuberculosis, viral hepatitis, and other similar infectious has been a huge challenge in developing countries. Public authorities and policy advocates have indicated that the CSDH framework provides a reasonable theoretical approach to effective control of these diseases (Centers for Disease Control and Prevention (CDC), 2010; Dean & Fenton, 2010, 2013). Though no study has applied the CSDH framework to studies related to Lassa fever, the determinants

identified for viral hepatitis, HIV/AIDs, and other STDs are known to also significantly influence the transmission and outcomes of many other infectious diseases. Such factors include poverty, housing conditions, and access to healthcare (CDC, 2010; Dean & Fenton, 2010). This study was designed to test the influence of these factors and related demographic factors on the transmission of Lassa fever.

## Literature Review Related to Key Variables and Concepts

### LASV

LASV is a single-stranded RNA virus belonging to the *Arenaviridae* family and is the cause of the common acute hemorrhagic illness, Lassa fever, in West Africa (Thairu & Egenti, 2015; Wolff et al., 2016). It is a smooth-surfaced spherical shaped virus measuring 70-150 nm consisting of small and large RNA fragments. LASV can be inactivated by heat, ultraviolet and gamma radiation and some chemical preparations such as 0.5% sodium hypochlorite, 0.5% phenol and 10% formalin (Thairu & Egenti, 2015). The susceptibility of the virus to these conditions is the basis for many infection control techniques used to interrupt transmission of the virus in households and healthcare settings.

LASV was discovered in 1969 in a village called Lassa, now in Borno State, North East Nigeria (Azeez-Akande, 2016; Ogoina, 2013) The search for the causative agent followed the illness of missionary nurses working in Jos Mission Hospital, Jos, Plateau State, Nigeria at that time (Achinge et al., 2013; Ogoina, 2013). Since then, Lassa fever outbreaks have been reported in many parts of Nigeria including other Northeastern States, middle-belt, and Southeastern States. More recently, intense outbreaks have been

reported in Edo, Ondo, and Ebonyi States (Awosanya, 2018; Gobir et al., 2019; Tambo et al., 2018). Consistently, LASV has been confirmed to be present in blood samples collected from many suspected cases of the disease.

**Transmission of Lassa Fever**

LASV is found in the urine, feces, blood and other body fluids of the vector rodents, commonly *M. natalensis* (Ogbu et al., 2007; Yun & Walker, 2012). Similarly, the virus can be isolated from urine, feces, blood, semen, and other body fluid samples of infected humans. When these body fluids come in contact with food items, water, hands, and surfaces, these items become contaminated. Human contact with these items puts the individual at risk of being infected (Nwonwu et al., 2018; Ogoina, 2013).

Transmission of Lassa fever occurs either through primary or secondary routes (Bonwitt et al., 2016; Lecompte et al., 2006; Saka et al., 2017; Tambo et al., 2018). Primary transmission occurs when the virus is transmitted from the rodent vector to man through exposure to the urine, feces, blood, and other body fluids of the rodent (Bonwitt et al., 2016). Contact with rodents may happen when the rodents invade households or breed in housing surroundings, thereby contaminating exposed foods, water, and domestic utensils. Persons who hunt rodents for food may also get infected (Bonwitt et al., 2016; Yun & Walker, 2012). Youths and children may deliberately set fire to bushes in the hope to catch fleeing rodents for consumption, with associated inadvertent spread of the fire leading to widespread burning (Aigbiremolen et al., 2012; Aigbiremolen et al., 2013). Bush burning, which encourages the migration of peridomestic rodents into nearby houses as they run for safety and in search of new abodes and food, occurs more

often in the dry season, a period which coincides with Lassa fever outbreaks (Achinge et al., 2013; Ogoina, 2013).

Secondary transmission refers to when an infected person transmits the virus to another person who was exposed to blood and body fluids of the infected person. This is fairly common among contacts that live in the same household with a Lassa case or were involved in supporting the sick person or even burying the dead (Eze et al., 2010; Tobin et al., 2015). Transmission among sexual contacts has also been documented (Tambo et al., 2018). Another form of secondary transmission with significant public health concern is nosocomial transmission where health care workers contact the virus in the process of caring for the sick in healthcare settings (Saka et al., 2017; Tambo et al., 2018). This has resulted in significant morbidity and mortality from healthcare associated infections especially where poor infection prevention and control practices are prevalent (Saka et al., 2017). Uncontrolled transmission of Lassa fever is associated with higher morbidity and mortality rates (Buba et al., 2018; Onah et al., 2020).

**Demographic Characteristics and Lassa Fever**

Important demographic characteristics that may be considered in the epidemiology of an infectious disease include age, gender, marital status, religion, ethnicity, and residence. Many of these factors may influence the distribution of Lassa fever in communities. It has been reported that all persons irrespective of age can be infected with Lassa fever—children, adults, and elderly alike (Ogbu et al., 2007; Ogoina, 2013). However, the severity of disease and survival from complications has been associated with age, especially among the elderly.

In a study done among Liberian refugees in Sierra Leone, 90 cases of Lassa fever were selected from hospital records at the Kenema General Hospital, and enrolled into a case-control study (Bonner et al., 2007). The authors reported that the risk for Lassa fever infection was significantly higher in females than in males. In addition, incidence risk for the infection was more than two times higher in the age group of 18-59 years compared to younger age groups or in those older than 59 years. The age group with higher risk was considered as an economically active group in the study (Bonner et al., 2007). Female gender and cases in children under 2 years of age were reported to consist of 45% and 40%, respectively, in a review of 83 suspected cases of Lassa fever in a children and women referral hospital in Bo district, in rural Sierra Leone (Dahmane et al., 2014). However, mortality was higher among females and among older children. Being a hospital-based study, the findings could not be generalized to the wider rural communities in the country known to experience repeated Lassa fever outbreaks.

Researchers in Guinea studied the risk factors for Lassa fever infection with particular respect to contact with rodents using a cross-sectional study design and found that habits of cutting up of rodents was rare among children but fairly common among adults (Kerneis et al., 2009). Conversely, habits of eating rodents were comparable among all age groups. The study also identified rural residence as a significant factor ($p$ = .003) that increased the risk of transmission of the virus among human populations (Kerneis et al., 2009). In the analysis of other demographic variables, age and gender were not significantly associated with a positive test for suspected cases of Lassa fever ($p$ = .73 and .36, respectively). Though the work captured information on religion and

occupation, it did not consider these demographic variables in the analysis and discussion of risk factors for Lassa fever. The characteristics of reported cases were taken into consideration in surveillance and other control efforts in the country.

Ilori et al. (2019) described the 2018 Lassa fever outbreak in Nigeria and showed that there was increasing CFR in older victims of Lassa fever. Their work was based on 423 laboratory-confirmed cases of Lassa fever reported mostly from Edo, Ondo and Ebonyi States of Nigeria from January to May 2018. The reporting forms used to capture data contained information on demographic features such as age, gender and residential address as well as other epidemiological data such as occupation and exposure history. The study also reported higher mortality among male than female patients though the difference was not statistically significant. The study did not provide any information on the influence of residence and other demographic characteristics on Lassa fever and its outcome.

The Lassa fever outbreak in Plateau State in 2016 was studied by Shehu et al. (2018) by conducting a review of 33 patients admitted for Lassa fever in the Jos University Teaching Hospital, Jos, a popular referral center for many North Central States in Nigeria. Though age, gender and occupation were considered in the review, there were no significant associations between the socio-demographic profile of subjects and their test results (confirmed versus suspected). The small sample size may have been responsible for the inability of the test statistic to detect a difference. However, a greater proportion (73%) of confirmed cases recorded resided in urban residential areas compared to 27% who were from rural areas.

In Edo State, a study carried out in Esan West Local Government Area (LGA), a highly endemic LGA, was done to assess the prevalence of risk factors and Lassa seroprevalence among 166 respondents from 50 households (Tobin et al., 2015). The authors examined age, marital status, level of education, and gender of the respondents in relation to seroprevalence of Lassa fever. The study found that older age groups, being presently or previously married and female gender were more significantly associated with the risk for Lassa fever than younger age groups, being an unmarried person, and male gender respectively. However, the outcome variable was seroprevalence, which is better indicative of exposure over the course of time irrespective of development of acute illness.

The foregoing review suggests that there is sparse or no robust information available in literature on the influence of demographic factors on the transmission of Lassa fever. There is limited information on the extent of influence of demographic factors on the occurrence of Lassa fever as the studies reviewed did not apply multivariate analysis to the identified factors. It is imperative to have a deeper understanding of the role of demographic characteristics on a disease like Lassa fever which commonly exhibit person-to-person transmission in endemic communities (Asogun et al., 2016; Gobir et al., 2019; Nwonwu et al., 2018).

**Socioeconomic Factors in the Transmission of Lassa Fever**

Closely related to demographic factors are socioeconomic factors that may influence the occurrence of disease and even health inequalities as captured in the CSDH framework (Dean & Fenton, 2010; Solar & Irwin, 2010). In some literature, demographic

and socioeconomic variables are considered together as socio-demographic variables. In this review, the important socioeconomic variables under consideration are occupation, employment status, education, income, access to healthcare services, and housing.

In a mixed method study to characterize rodent hunting and consumption in Sierra Leone, an acceptance of hunting rodents in the context of exposure to Lassa fever was significantly associated with lower educational attainment (Bonwitt et al., 2016). Similarly, primary education level was more strongly associated with consumption of rodents than secondary educational level attainment among the respondents. The study focused mainly on human behavior towards Lassa fever vectors and did not provide information on how the examined socioeconomic factors affected disease occurrence directly. In addition, other important factors such as occupation and income were not explored by the researchers.

Bonner and colleagues assessed the relationship between housing quality and the risk for Lassa fever in refugee camps in Sierra Leone and found that poor housing quality was an important determinant of rodent infestation and Lassa fever infection (Bonner et al., 2007). Using housing quality and external hygiene scores developed by the authors, they found that case houses scored significantly worse in the quality of housing and external hygiene. This study was limited to refugee camps which are likely different from regular residential settings, thus limiting the generalizability of the study. Housing has been noted to be a relevant consideration in describing transmission of Lassa fever and in deploying effective control mechanisms (Gbakeji et al., 2016; Gibb et al., 2017). Gbakeji et al. (2016) identified house fittings, house screenings, housing amenities, housekeeping,

and house surroundings as aspects of housing quality that can attract or repel rodents implicated in the transmission of Lassa fever. The authors, after gleaning information from existing literature, posited that poor housing quality is a major challenge in the control of vector-borne diseases. Housing is considered a local practice, like land use and rodent consumption, that is related to the risk of Lassa fever in West Africa (Gibb et al., 2017).

In a review of 34 cases of Lassa fever in Jos, North Central Nigeria, Shehu et al. (2018) reported that occupation was not significantly associated with the occurrence of Lassa fever, though there were more confirmed Lassa fever cases among business men/women, farmers and health care workers compared to students and office workers ($p$= .40). In the small sample-sized study, no other socioeconomic factor was considered and even the few socio-demographic feature examined were not analyzed against severity or mortality of the disease among the subjects. Workers in the health care profession have been found to be at higher risk of Lassa fever infection compared to other occupation (Ilori et al., 2019). Ilori and colleagues investigated an outbreak of Lassa fever in Nigeria in 2018 by analyzing data of suspected and confirmed cases using the chi-square test to compare exposure history of health care workers (HCWs) and non-HCWs. They found that HCWs were significantly at greater risk of infection due to exposure to suspected or confirmed cases ($p < .0001$).

The roles of housing quality and hygiene were examined in a study that looked at the impact of housing quality on Lassa fever transmission in Edo State (Ochei et al., 2014). The study which utilized a cross-sectional design was carried out among 247

houses in two settlements in Ekpoma and showed that poor hygiene rather than housing quality was significantly associated with transmission of Lassa fever. Though education and occupation of study participants were described, the relationships between these socioeconomic variables were not examined. The authors recommended the promotion of cleaning houses and surroundings in the control of Lassa fever.

In another study to assess environmental risk factors for transmission of Lassa fever among university students in Edo State, housing factors such as overcrowding, poor waste management and structural defects such as openings in ceilings, doors and windows were found to be prevalent in on-campus residence (Aigbiremolen et al., 2017). The study was a cross-sectional study and was conducted using cluster sampling techniques among 423 students in 6 residence halls. Specifically, all (100%) of the halls were overcrowded and all respondents reported the presence of rodents in and around the buildings. The study focused mostly on sanitary and housing factors and did not link the risk factors assessed with known cases of Lassa fever.

## Summary and Conclusions

A number of studies have highlighted the nature and problems of Lassa fever in communities in developing countries including Nigeria. The disease, caused be an RNA virus, is a vector-borne infection that can be transmitted from infected rodents to man and from an infected person to others. There are variations in the severity and mortality of Lassa fever with regards to individual patient characteristics such as age and gender as has been reported in some studies in West Africa. Similarly, challenges in the control of

the viral hemorrhagic disease have been complicated by poor housing conditions and sanitation in some areas.

A review of existing literature revealed that infectious disease like non-communicable diseases can be influenced by social determinants. However, there are few or no studies so far that have adequately explored how demographic and socioeconomic factors influence the transmission of Lassa fever. This study, by investigating the demographic and socioeconomic characteristics of a selected population in a state that often experiences Lassa fever outbreaks, intends to document empirical evidence of the relationship between these factors and transmission of the LASV. In the next chapter, the methodology that was adopted in meeting the aim and objectives of this study will be described.

# Chapter 3: Research Method

The purpose of this dissertation was to investigate the various demographic and socioeconomic factors that influence the occurrence and transmission of Lassa fever in Edo State and to provide evidence for the consideration of these factors in the control of Lassa fever. In this chapter, the methods that were used to determine the significance or otherwise of the influence of demographic and socioeconomic variables in the transmission of Lassa fever are described. In addition, this chapter includes the study design, recruitment, data collection, data analysis plan and ethical procedures.

## Study Design and Rationale

The descriptive cross-sectional study design was used for this research. It is an observational research design in which the researcher is a passive observer and does not in any way manipulate the variables of study (Sabin, 2012). In observational study designs, the investigator is able to control various aspects of the study including design, sampling techniques, and data collection and the exposure and outcome are studied simultaneously (Carlson & Morrison, 2009).

The cross-sectional study design is a quantitative approach. Quantitative research is deductive, variable-centered, and numerical in sense, and it is used to substantiate components of a framework selected for a research (Creswell, 2014; Kelly, 2011; Woods, 2015). A cross-sectional study is useful in testing research hypothesis and determining associations between study variables. It requires less time and often fewer resources to generate the required data compared to longitudinal studies, which require follow-up data collections over a period of time (Habib et al., 2014; Mann, 2003). However, cross

sectional study designs are not able to determine causation of a phenomenon because it lacks the element of temporality (Glass et al., 2013; Lucas, 2012). In this study, the design provided me a means to assess the association between the variables in the study. These variables already existed and were not manipulated in the course of the research.

## Methodology

### Population and Study Area

The target population for this study consisted of the affected residents of Edo State, Nigeria. Edo State is located in the South-South geopolitical zone of Nigeria and the people are known for arts, craft, and farming (Ojeifo & Eseigbe, 2012). The state, which has a land mass of 19,802 $km^2$ with a population of 4.5 million persons, shares boundaries with the states of Kogi in the north, Delta in the south, Ondo in the west, and Kogi and Anambra in the east (Ogwuche et al., 2016).

Edo is divided into three senatorial districts which are Edo South, Edo Central and Edo North senatorial districts. There are 18 LGAs in the state and the main ethnic groups are the Edos, Afemais, Esans, Owans, and Akoko-Edos (Edo State Government of Nigeria, 2017). The LGAs are further divided into wards ranging from 10 to 12 wards per LGA. Apart from other common diseases like malaria, typhoid fever, and infectious diarrhea, Lassa fever is a major health problem in the State especially in the north and central senatorial districts (Eze et al., 2010; Tobin et al., 2015).

### Sampling and Sampling Procedures

After obtaining IRB approval from Walden University, a multistage sampling technique was used to select the participants in this study. Multistage sampling is an

appropriate probability sampling method for selecting study units in an observational quantitative study (World Health Organization, 2017). In the first stage, two Lassa fever-reporting LGAs each were selected from the three senatorial districts in the state using simple random sampling technique. Six LGAs were selected at this stage: Etsako West, Etsako Central, Esan North East, Esan West, Ovia North East, and Uhunmwode. In the second stage, lists of wards in the selected LGAs that have reported Lassa fever in the last 2 years were drawn up. From this list, two wards each per LGA were randomly selected and where only one ward met the criteria, only that ward was taken.

Furthermore, two Lassa fever-reporting communities were randomly selected from each of the selected wards. Thereafter, the quarters/settlements in each selected community were listed and three settlements were selected by simple random sampling technique from the list for each ward. Each selected settlement was studied using the cluster technique (WHO, 2017). In each cluster, every adult who met the inclusion criteria and granted consent was interviewed. In order to have a fair representation of respondents from communities with confirmed cases of Lassa fever, it was ensured that at least one of the settlements selected was one that had reported cases of Lassa fever in the last 2 years preceding the study.

## Selection Criteria

The following inclusion and exclusion criteria were applied in the selection of study participants.

### *Inclusion Criteria*

Participants who were included in this study were

- residents in communities where Lassa fever cases have been reported in the last 2 years preceding the study, and
- persons confirmed to be cases of Lassa fever within the preceding two (2) years to the start of data collection.

***Exclusion Criteria***

Those who were excluded from the study were

- residents who have lived less than 6 months in the selected communities—this criterion was to ensure that persons who have not been sufficiently exposed to the social and demographic environment in the selected communities were excluded from the study,
- persons who were not available to respond to the questionnaire after two scheduled meetings during the data collection period, and
- any person who was still undergoing treatment for Lassa fever following a recent diagnosis.

**Sample Size and Power of the Study**

The sample size for this study was determined using the Cochran formula for calculating sample size for cross sectional studies when proportion is the parameter of study (Cochran, 1963; Kasiulevičius et al., 2006; Mann, 2003):

$$n = Z^2 \frac{p(1-p)}{e^2} ;$$

Where,

$n$ = sample size

$Z$ = 1.96 for 95% level of confidence for at power of 80%

$P$ = prevalence of the event of interest. In this case, $P$ is the prevalence of Lassa fever in Edo State, and it is unknown. Therefore, a national sero-prevalence of 21.3% was used in this study (Tambo et al., 2018).

$e$ = margin of error or precision of 5% (Ogbonna, 2014).

Therefore,

$n = [(1.96)^2 (0.213x0.787)]/(0.05)^2$

$n$ = 257.5

A response rate of 90% was assumed:

$n$ = 257.5/0.9= 286.1

Thus, the minimum sample size for this study was 286 persons.

**Procedure for Recruitment, Participation and Data Collection**

***Community Mobilization***

In order to ensure maximum cooperation from respondents, I carried out community mobilization activities in the selected LGAs and communities including paying advocacy visits to the authorities of the selected LGAs to intimate them of the purpose and nature of the research. I also visited the community leaders of the various communities and settlements to solicit for their support in carrying out the study.

***Data Collection***

This study used mainly primary data to meet its aim and objectives. Primary data were obtained by use of a structured questionnaire that was administered to respondents in the selected settlements as described above. Secondary data, such as maps of Lassa

fever in Edo State and Lassa fever surveillance register including data on Lassa fever reporting LGAs, wards, and communities, were obtained from the Edo State Ministry of Health, Benin City, Nigeria.

The questionnaire was administered to study participants by me. A few participants who preferred to be given the questionnaires to fill out and return were obliged. Some other participants were mailed the questionnaires and returned them after filling them out. For the face-to-face interviews, the administration of the questionnaire was done in designated meeting points in the community halls or in a private section of available public health care facility in the community. In all instances of interactions with study participants and other stakeholders, COVID-19 prevention guidelines such as physical distancing, use of face masks, and hand hygiene were adhered to (NCDC, 2020).

As part of the community mobilization earlier described, study participants were informed of the study and the processes involved through invitation letters extended to them through their community leaders and by emails. I also informed respondents the government's permission to carry out the study. The process of questionnaire administration involved introducing the researcher, obtaining informed consent, and obtaining responses to each item on the questionnaire. Respondents who required another scheduled time to complete the interview were given the opportunity.

## Instrumentation and Operationalization of Constructs

### *Study Instrument*

The study instrument used for this research is a structured questionnaire (see Appendix A) consisting of four sections: introduction, demographic characteristics of

participants, socioeconomic factors, and occurrence of Lassa fever. I developed the questionnaire after reviewing existing literature on the subject of the research and in consideration of the research questions. The questionnaire was checked for ability to identify and measure all the study variables (Yaghmaie, 2003). Furthermore, the questionnaire was reviewed by two public health experts who have experience in Lassa fever research (Yaghmaie, 2003; Zamanzadeh et al., 2015). I used the feedback from these experts to improve the questionnaire.

The reliability of the questionnaire was assessed by pre-testing it in Esan Central LGA, an LGA other than the selected ones for the study. Esan Central LGA has similar sociocultural and geographical characteristics as the study LGAs. These steps were taken to ensure the comprehensiveness and appropriateness of the questions that make up the questionnaire. After reviewing the copies of the questionnaire used for the pretest, no modification of the questionnaire was required.

***Operationalization***

The dependent variable in this study was presence of confirmed cases of Lassa fever within an LGA ward in the last 2 years. This was further classified into low burden (< 10 cases), medium burden (10–19 cases), and high burden (≥ 20 cases) wards. Closely related to this variable is the prevalence of Lassa fever in the study area expressed as a fractional decimal.

The independent (exposure) variables in this study included demographic and socioeconomic variables as defined in Table 1:

**Table 1**

*Independent Variables*

| SN | Variable | Definition | Scale |
|---|---|---|---|
| Demographic variables | | | |
| 1 | Age | The completed years of life as at data collection. | Ratio |
| 2 | Gender | The characteristic male or female phenotype of a respondent. | Nominal |
| 3 | Marital status | Current status with respect to being married to a man or woman. | Nominal |
| 4 | Residence | Whether the respondent is living in a rural or urban community as defined by national (Nigerian) guidelines. | Nominal |
| 5 | Ethnicity | The ethnic group the respondent belongs to. | Nominal |
| Socioeconomic variables | | | |
| 1 | Occupation | The nature of work the respondent is employed in. | Nominal |
| 2 | Employment status | Being employed in a paying job at least the last six months. | Nominal |
| 3 | Education | The level of education ranging from no education to tertiary education. | Ordinal |
| 4 | Income | The average monthly earnings in dollars. | Ratio |
| 5 | Access to health care | The proportion of respondents living within 5km of a functional health facility.[1] | Nominal |
| 6 | Housing condition | The structural and surrounding qualities of a house that protects it from infestation with rodents. | Ordinal |

[1](MEASURE Evaluation, 2015; WHO, 2015). *Note.* SN= serial number.

Demographic factors are existing characteristics of individuals. That is, these variables are not features that will be generated by some intervention as is the case in experimental studies. In this study, information on these factors in the study population was obtained and analyzed to see how they relate to the occurrence and transmission of Lassa fever.

Socioeconomic determinants of disease include income levels, occupation, educational attainment and residence (Jayasinghe, 2015; Solar & Irwin, 2010; Suhrcke et al., 2011). Using a cross-sectional study design, I was able to capture information on the current status of these socioeconomic determinants in the study population, and these data were explored to understand the variation in the transmission of Lassa fever across different endemic communities.

**Data Analysis Plan**

The data points in the questionnaire were collated, sorted, and coded. The questionnaires were anonymized, and the coded links saved in a confidential computer system accessible only to me and an assigned research assistant. Coded data were entered into a spreadsheet and analyzed using Statistical Package for Social Sciences (SPSS, Version 26; International Business Machines, 2020).

Test of associations between variable proportions was carried out with the use of appropriate test statistics. Specifically, I used chi square (Disha, 2019; du Prel et al., 2010) to test the association between transmission of Lassa fever and dichotomous demographic and socioeconomic variables. Multinomial logistic regression was used to determine significant determinants of Lassa fever transmission in the study area.

Statistical level of significance was set at $p < .05$. Results of data analysis are presented in tables in Appendix B and Figures 2 and 3.

The research questions and hypotheses addressed in this study and the specific tests that were applied are given below:

***Research Question 1***

What are the significant demographic determinants (age, gender, marital status, type of residence, and ethnicity) of Lassa fever transmission in endemic communities in Edo State?

$H_0$1: There are no significant demographic factors implicated in the transmission of Lassa fever in endemic communities in Edo State.

$H_1$1: There are significant demographic factors implicated in the transmission of Lassa fever in endemic communities in Edo State.

The answer to this research question was determined by testing the association between age groups, gender, marital status, and residence on the one hand and the graded number of reported cases of Lassa fever in the selected wards on the other hand with chi-square test (du Prel et al., 2010; Laerd Statistics, 2018). In addition, multinomial logistic regression (Bayaga, 2010; Laerd Statistics, 2013; Stoltzfus, 2011) was used to determine the significant demographic predictors of Lassa fever transmission in the communities.

***Research Question 2***

What are the significant socioeconomic factors (occupation, employment status, educational attainment, income level, availability of healthcare services, and housing) that determine the transmission of Lassa fever in Edo State?

$H_0$2: Socioeconomic factors are not significant in the transmission of Lassa fever in endemic communities in Edo State.

$H_1$2: Socioeconomic factors are significant factors in the transmission of Lassa fever in endemic communities in Edo State.

The assessment of Research Question 2 was done by determining the relationship of socioeconomic factors- employment status, occupation group, education, income levels, housing conditions and ethnicity with transmission of Lassa fever in Edo State by chi-square test (du Prel et al., 2010; Laerd Statistics, 2018). Multinomial logistic regression (Bayaga, 2010; Bursac et al., 2008; Laerd Statistics, 2013; Stoltzfus, 2011) was also used to assess the influence of these factors on Lassa fever transmission. The tests showed the associations and what the significant predictors are and the odds of occurrence.

***Research Question 3***

Is there an association between residence and Lassa fever deaths in Edo State?

$H_0$3: There is no association between residence and Lassa fever deaths in endemic communities in Edo State.

$H_1$3: There is an association between residence and Lassa fever deaths in endemic communities in Edo State.

The ward-by-ward proportion of deaths were calculated as fractional decimals and classified into two groups. This was based on the number of cases and deaths reported from the LGAs in the two years preceding data collection. Chi-square test(du Prel et al.,

2010; Laerd Statistics, 2018) was used to test the association between categories of residence (urban versus rural) and Lassa fever deaths.

## Threats to Validity

This work was an observational study with a quantitative approach. The design of the study being cross-sectional did not allow concerns for internal validity to be adequately handled as would have been the case for case-control or randomized control trial studies. Observational studies are not able to establish causality as proposed in the Hill's criteria (Creswell, 2014; Rothman & Greenland, 2005). However, the ability to test for hypotheses and determine association between variables makes cross-sectional studies useful in adding to the body of existing knowledge (Carlson & Morrison, 2009). In this study, threat to external validity had to do with the way the sample was selected and its potential influence on the generalizability of study outcomes as well as its usefulness to other populations (Creswell, 2014; Mann, 2003). To address threats to external validity, I selected participants using probability sampling techniques (random and cluster sampling stages in a multi-stage procedure). Probability sampling ensures randomness in the selection of study elements and minimizes selection bias (Schutt, 2011; WHO, 2017). By using the multistage sampling technique, the sample was highly representative of the target population.

Threats to construct validity were addressed by clear definitions of what the dependent and independent variable mean as has been shown in Table 1. These definitions were adhered to throughout the data collection and analysis processes. Appropriate statistical tests such as chi-square and multiple logistic regression were

applied in testing the relationships between the variables in this study to avoid threats to statistical conclusion validity (Creswell, 2014).

## Ethical Procedures

The following ethical procedures were followed for this study:

1. IRB approval: The proposal for this study was submitted to the IRB of Walden University for approval before data collection. The IRB approval number was 01-07-21-0427553.
2. Ethical clearance from Edo State Ministry of Health: I also applied for and obtained ethical clearance after submitting the approved proposal to Edo State Ministry of Health Research Ethics Committee.
3. Approval from LGA and community authorities: I sought and obtained the approval and cooperation the Department of Primary Health Care in the selected LGAs where this study was carried.
4. Consent from participants: In order to protect the dignity, rights and welfare of participants in this study, this candidate adhered to the principles of research ethics as recommended in literature (Creswell, 2009; Walden University, 2018; WHO, 2018). The type of consent that was obtained from participants in this study was informed written consent. The consent form contained clear information regarding the purpose and nature of the study and the kind of data to be collected. Study participants who responded to the questionnaires after reading the consent form and listening to explanations provided by the researcher were assumed to have given implied consent. They

were not required to write their names on or sign the consent form so as to guarantee privacy. However, respondents were given copies of the consent form to keep for reference. Confidentiality was maintained by anonymizing the filled questionnaires and keeping them in a safe accessible only to the researcher.

5. Data Protection: All data of study participants were stored in a dedicated computer accessible to only the researcher. Data from the research was used only for the purpose of this research and will be destroyed 5 years after this research must have been completed and approved by Walden University.

## Summary

This work being an observational study, I have adopted the cross-sectional study design to answer the research questions. In this chapter, the procedure of recruitment of participants has been described. It involved selecting participants in some LGAs in Edo State using the multi-stage sampling technique. The sample size was determined using the Cochran formula for cross-sectional studies. The dependent variable in the study is the transmission of Lassa fever (measured by reported cases) in Edo State while the independent variables are defined demographic and socioeconomic factors.

I used a structured questionnaire I designed, following in-depth literature review and review by experts knowledgeable and experienced on the research subject, for data collection. Data collection was done after I obtained Walden's IRB approval. Further to complying with research regulations in Nigeria, I also obtained ethical clearance from the

Research Ethics Committee in the Ministry of Health, Edo State, Nigeria. I carried out the data analysis using the SPSS computer software and the appropriate statistical tests.

# Chapter 4: Results

The purpose of this dissertation was to examine demographic and socioeconomic factors that influence the occurrence and transmission of Lassa fever in Edo State and to provide evidence for the consideration of these factors in the control of Lassa fever. There are three research questions this study set out to answer.

In this chapter, I discuss the time for data collection and the representativeness of the sample. The chapter also contains descriptive characteristics of the sample, basic univariate analysis, and results of statistical analyses. Furthermore, the answers to the research questions are illustrated with statistical results. Figures showing results are presented in this chapter, whereas the tables are shown in Appendix B. The research questions and the related hypotheses are as follows:

1. What are the significant demographic determinants (age, gender, marital status, type of residence, and ethnicity) of Lassa fever transmission in endemic communities in Edo State?

$H_0$1: There are no significant demographic factors implicated in the transmission of Lassa fever in endemic communities in Edo State.

$H_1$1: There are significant demographic factors implicated in the transmission of Lassa fever in endemic communities in Edo State.

2. What are the significant socioeconomic factors (occupation, employment status, educational attainment, income level, availability of healthcare services, and housing) that determine the transmission of Lassa fever in Edo State?

$H_0$2: Socioeconomic factors are not significant in the transmission of Lassa fever in endemic communities in Edo State.

$H_1$2: Socioeconomic factors are significant factors in the transmission of Lassa fever in endemic communities in Edo State.

3. Is there an association between residence and mortality of Lassa fever in Edo State?

$H_0$3: There is no association between residence and mortality of Lassa fever in Edo State.

$H_1$3: There is an association between residence and mortality of Lassa fever in Edo State.

## Pilot Testing

After IRB approval, I carried out pilot testing of the study questionnaire by administering 15 copies (5% of the minimum sample size calculated) to respondents in Esan Central LGA. There was no required modification of the study instrument after reviewing the responses obtained during the pretesting of the questionnaire.

## Data Collection

The data collection for this study commenced after IRB approval from the second week of January 2021 to first week of February 2021. The minimum sample size for this study was 286. Three hundred and fifty persons were recruited but 336 persons responded to the questionnaires, giving a response rate of 96%. A higher number of persons than the minimum sample size of 286 were recruited for the study because every person who met

the selection criteria and gave consent in the selected settlements (clusters) was included in the study.

Out of 18 LGAs across three senatorial districts in Edo State, six LGAs were randomly selected to participate in the study. They were Etsako West, Etsako Central, Esan North East, Esan West, Ovia North East, and Uhunmwode LGAs. Etsako West and Etsako Central LGAs represented Edo North district, Esan North East and Esan West LGAs represented Edo central district, and Ovia North East and Uhunmwode LGAs represented Edo south district. Thus, all districts in the state were represented in the study.

## Results

### Descriptive Results

Table 2 shows the frequency distribution of demographic characteristics of participants in this study. The table shows that the highest proportions of respondents were found in Esan West and Etsako West LGAs (20.8% and 18.8%, respectively). The least proportion of respondents (12.8%) was found in Ovia North East LGA. The mean age of respondents was 37.2 (±13.1) years with the age group of 18–29 years being the largest group (32.7%). Respondents who were aged 60 years or more made up the smallest group accounting for 6.0%.

Male and female respondents were almost equally distributed, females being slightly more with a proportion of 50.9%. With respect to marital status, a majority of study participants were married, making up 63.1% of the sample. Divorced or separated participants were the least number of participants and accounted for 2.7% of respondents.

Respondents living in rural communities were the majority (76.5%) compared to those living in urban areas (23.5%). Table B2 also shows that the largest ethnic groups were Esan and Afemai (36.6% and 35.4% respectively).

Figure 2 shows the distribution of household sizes of respondents in the study. The greatest number of participants resided in households with more than four persons (52.7%) compared to 6.8% of respondents who lived in households with only one person. The mean household size was 4.8 (±2.3) persons.

**Figure 2**

*Size of Households of Respondents (N=336)*

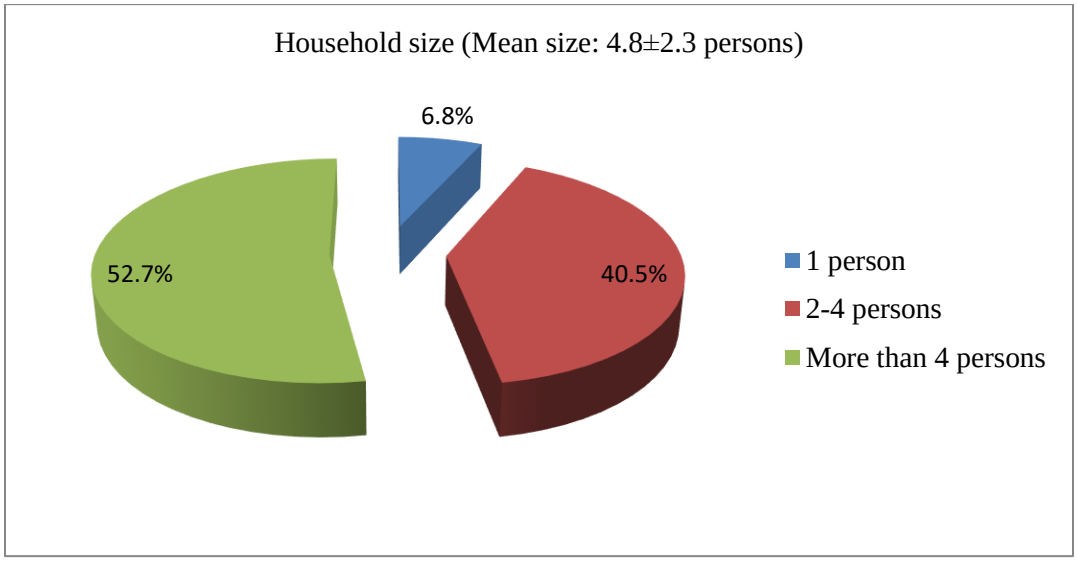



Table B3 shows that 67.0% of respondents were self-employed and 28.6% of them were employed in business/trading in the last two years. The majority of respondents (67.3%) earn less than $100 as personal income monthly, and 67.6% also earn less than $100 as household income monthly. However, the median monthly

personal income was $39, whereas median monthly household income was $65. Almost a third of respondents (32.4%) have had secondary education, but those with tertiary education were 37.8%. Functional health facilities were reported to be present in the communities of 91.4% of respondents and such facilities are within a distance of 5km for 73.5% of respondents.

Figure 3 shows that a primary health center was indicated as the available type of health facility in the community of 74.6% of respondents. Only 0.7% of respondents reported a tertiary health facility being present in their communities.

Table B4 shows that 69.9% of study participants live in brick houses and 54.8% said they have identified rodent entry points in their houses. It was found that 40.5% of participants had 1-4 rodent entry points in their houses, whereas 64.6% had open waste bins or dump sites in their premises. In 61.6% of respondents' houses, the surroundings were well kempt.

**Figure 3**

*Types of Health Care Facilities in the Community of Study Participants (n = 307)*

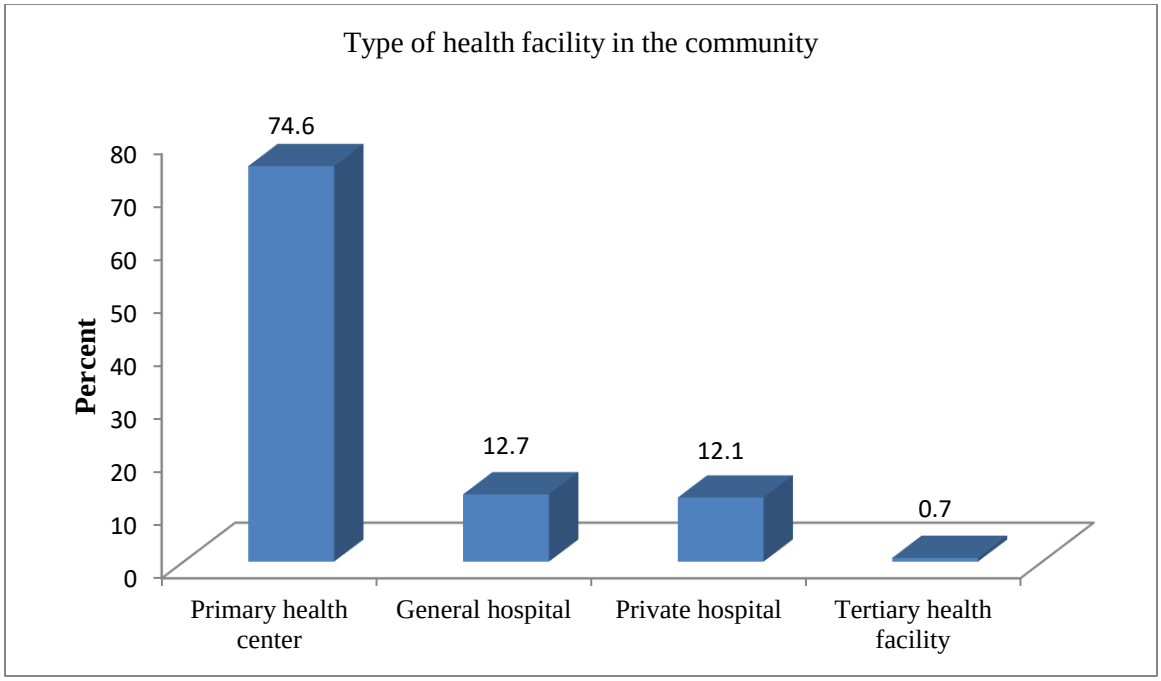



Table B5 shows that more than half (55.4%) of respondents were found in Lassa fever low burden wards, whereas 31.8% live in high burden wards. Additionally, 17.6% of respondents were Lassa fever cases diagnosed previously, and 7.1% reported knowing of other Lassa fever cases in their houses. Respondents also reported a previous Lassa fever death in their houses in 3.6% of instances.

## Statistical Analysis

### *Statistical Tests and Assumptions for Chi-Square Test*

I used Pearson's chi-square test and multinomial logistic regression analysis to address the three research questions in this study. Chi square was used to test the significance of associations between independent variables (demographic and socioeconomic) and transmission of Lassa fever. The assumptions of Pearson's chi-

square test are that the variables are measured in nominal or ordinal scale (categorical data) and that the variables consist of two or more categorical, independent groups (du Prel et al., 2010; Laerd Statistics, 2018). In this work, the assumptions for chi-square analysis were fulfilled.

### *Statistical Tests and Assumptions for Multinomial Logistic Regression*

Multinomial logistic regression was used to determine the significance of the influence of independent variables on the dependent variable (transmission of Lassa fever as measured by cases of Lassa fever). The important assumptions of multinomial logistic regression are the following: (a) the dependent variable is measured on a nominal scale and has more than two categories, (b) there are one or more independent variables that may be continuous, ordinal, or nominal, and (c) the dependent variable have mutually exclusive and exhaustive categories (Bayaga, 2010; Laerd Statistics, 2013). The dependent variable for this test was transmission of Lassa, which was measured by the burden (low, medium or high) of cases reported in the 2 years preceding this study. The variables tested with multinomial logistic regression in this study met these assumptions. In addition, only independent variables that showed *p* values of less than .25 in the univariate analysis were included in the multinomial logistic models. The selection of variables was to allow for adequate inclusion of significant and confounding covariates (Bursac et al., 2008; Chowdhury & Turin, 2020; Hosmer & Lemeshow, 2000).

## Findings of Statistical Analysis

### *Analysis for Research Question 1*

RQ 1: What are the significant demographic determinants (age, gender, marital status, and type of residence) of Lassa fever transmission in endemic communities in Edo State?

$H_O1$: There are no significant demographic factors implicated in the transmission of Lassa fever in endemic communities in Edo State.

$H_A1$: There are significant demographic factors implicated in the transmission of Lassa fever in endemic communities in Edo State.

Table B6 shows that the highest proportions of respondents residing in the high burden areas were those in the age groups of 30–39 years (38.7%) and 40–49 years (35.7%). The chi-square results in Table B6 show that there was no statistically significant association between and age and transmission of Lassa fever ($\chi^2 = 10.857$, $p = .210$).

Table B7 shows a slightly higher proportion of male respondents residing in Lassa fever high burden area compared to females (33.4% vs. 30.4%). The association between gender and Lassa fever transmission was not statistically significant ($\chi^2 = 0.538$, $p = .764$).

Table B8 shows that more than half (55.2%) of married respondents live in Lassa fever low burden areas, whereas singles were the largest group of respondents by marital status (37.8%) who reside in high burden communities. The chi-square result shows no

significant association between marital status and transmission of Lassa fever ($\chi^2$ = 10.950, $p$ = .090).

Table B9 shows that a higher proportion of urban respondents were residing in Lassa fever high burden areas compared to those residing in rural areas (62.0% vs. 22.6%). Conversely, majority (66.1%) of rural respondents live in low burden areas. The association between residence and Lassa fever transmission was statistically significant ($\chi^2$ = 54.490, $p$ < .001).

Cross tabulation of household size with Lassa fever transmission is shown in Table B10. About a third (33.8%) of respondents in household size of 2–4 persons reside in high burden communities for Lassa fever transmission, whereas the majority of those in single person households (65.2%) reside in low burden communities. However, there was no statistically significant association between household size and Lassa fever transmission ($\chi^2$ = 1.535, $p$ = .820).

In Table B11, a cross tabulation between ethnic group and Lassa fever transmission is shown. More than half (50.4%) of Esan respondents reside in Lassa fever high burden areas, whereas the majority (78.8%) of Edo respondents reside in low burden communities. The table also shows that there was a statistically significant association between ethnic group and Lassa fever transmission ($\chi^2$ = 66.648, $p$ < .001).

From the results of the analysis of demographic variables and their associations with Lassa fever transmission, there was a significant association between residence and Lassa fever transmission and between ethnic group and Lassa fever transmission. Thus, the null hypothesis, which states that there are no significant demographic factors

implicated in the transmission of Lassa fever in endemic communities in Edo State is rejected.

The model fitting information provided in Table B12 shows a final chi-square of 88.454 and $p < .001$ and indicates that the model statistically significantly predicted transmission of Lassa fever. Also, the goodness-of-fit shown in Table B13 for this multinomial logistic regression showed a Pearson chi-square of 343.248 and $p = .199$ indicating that the model has a good fit.

Table B14 shows that age was not a significant predictor of transmission of Lassa fever when comparing low transmission with high transmission and when comparing medium transmission with high transmission. However, for low transmission, rural residence demonstrated statistical significance ($p < .001$). The table shows that those living in rural communities are 6.991 times more likely to reside in areas that have low rates of Lassa fever transmission (B = 1.945, 95% CI [3.580, 13.651]). The table also shows that Esan ethnicity decreases the odds of being in a low Lassa fever transmission community by 0.344 (B = -1.066, CI [0.164, 0.720]).

***Analysis for Research Question 2***

RQ2: What are the significant socioeconomic factors (employment status, occupation, educational attainment, income level, availability of healthcare services, housing and ethnicity) that determine the transmission of Lassa fever in Edo State?

$H_0$2: Socioeconomic factors are not significant in the transmission of Lassa fever in endemic communities in Edo State.

$H_1$2: Socioeconomic factors are significant factors in the transmission of Lassa fever in endemic communities in Edo State.

Table B15 shows that 37.1% of respondents are employed under public or private authority and 36.6% of unemployed respondents live in Lassa fever high burden areas. More than half (57.3%) of self-employed respondents live in low burden areas. There was no statistically significant association between employment status and Lassa fever transmission.

Table B16 show respondents whose major occupation in the last two years were civil servant/private worker and business/trading made the highest proportion of those residing in high burden communities with respect to Lassa fever transmission. Majority (85.7%) of farmers live in low burden communities. The association between occupation and Lassa fever transmission was statistically significant ($\chi^2$= 46.490, $p$< .001).

The cross tabulation of educational attainment and Lassa fever transmission shown in Table B17 shows that the proportions of respondents living in low burden areas for those with no formal, primary, secondary, and tertiary education were 60.0%, 55.7%, 59.6%, and 50.4% respectively. The highest proportion (38.6%) for high burden communities was found among respondents with tertiary education. The table also shows that there was no statistically significant relationship between educational attainment and Lassa fever transmission ($\chi^2$= 9.426, $p$ = .151).

Table B18 shows that respondents earning 100-199 USD monthly personal income had the highest proportion (44.8%) among those living in Lassa fever high burden areas while majority (80.0%) of those earning 200-299 USD monthly personal

income reside in low burden areas. The Fisher's exact test result showed a non-significant relationship between personal income and Lassa fever transmission (Fisher's exact test value= 9.312, $p$ = .107).

Table B19 shows that a greater fraction of those whose monthly household income was ≥100USD lives in high burden communities for Lassa fever (41.3% vs. 27.3%). Conversely, respondents whose monthly household income was <100 USD presented a greater proportion of those who live in low burden areas (59.5%). The association between monthly household income and Lassa fever transmission shown in the table was statistically significant ($\chi^2$= 6.749, $p$ = .034).

Table B20 indicates that only 31.3% of respondents that reported having a health facility in their community reside in Lassa fever high burden communities and a higher proportion of 37.9% is indicated for respondents without a health facility in their community. The chi-square results shown in the table indicates that there was no statistically significant association between availability of functional health facility and Lassa fever transmission ($\chi^2$ = 4.689, $p$ = .096).

Table B21 shows that poor housing conditions were more prevalent (39.7%) in Lassa fever high burden areas compared to a lower proportion of 14.4% for good housing conditions for the same high burden areas. Conversely, the majority (75.0%) of respondents with good housing conditions reside in low burden areas. The table also shows that there was a statistically significant association between housing condition and Lassa fever transmission ($\chi^2$ = 25.435, $p$ < .001).

The results of the chi-square analysis for variables considered in RQ2 showed that there were significant associations between occupation, monthly household income, and housing condition, and Lassa fever transmission. Therefore, the null hypothesis, which states that socioeconomic factors are not significant in the transmission of Lassa fever in endemic communities in Edo State is rejected.

Table B22 and Table B23 show the parameters of the model fitting information and goodness-of-fit for the multinomial logistic regression model that was applied to the relationship between socioeconomic factors and Lassa fever transmission. A final significance of $p < .001$ in the model fitting information and a Pearson chi square of 563.488 with $p = .152$ (not statistically significant) in the goodness-of-fit table show that the model was appropriate in predicting Lassa fever transmission.

Table B24 shows the relationship between socioeconomic factors and Lassa fever transmission in a multinomial logistic regression model. For low Lassa fever transmission, formal occupation and poor housing showed statistical significance ($p = .008$ and $p < .001$ respectively). The table shows that formal occupation (employment under public or private authority) decreases the risk of low LF transmission by 0.387 relative to living in high Lassa fever transmission communities (B= -0.949, CI: 0.192-0.782) while poor housing decreases the risk of being resident in a low Lassa fever transmission community by 0.185 relative to residence in high Lassa fever transmission community (B= -1.686, CI [0.096, 0.356]). Thus, there is a statistically significant inverse relationship between formal occupation and poor housing as predictors, and low Lassa fever transmission as an outcome.

For medium Lassa fever transmission, formal occupation, at least secondary education, and poor housing showed statistical significance (p= 0.018, p= 0.040, and p= 0.036 respectively). The regression analysis shows that formal occupation decreases the risk of being in a medium Lassa fever transmission community by 0.217 (B= -1.527, CI [0.061, 0.770]), having at least secondary education decreases it by 0.434 (B= -0.835, CI [0.196, 0.163]), while poor housing decreases it by 0.373 (B= -0.987, CI [0.149, 0.935]) and each relative to residence in high Lassa fever transmission community. In essence, formal occupation, attaining a minimum of secondary education, and poor housing all have statistically significant inverse relationship with medium Lassa fever transmission relative to high Lassa fever transmission when other variables in the model are held constant.

***Analysis of Research Question 3***

RQ3: Is there an association between residence and mortality of Lassa fever in Edo State?

$H_03$: There is no association between residence and mortality of Lassa fever in Edo State.

$H_13$: There is an association between residence and mortality of Lassa fever in Edo State.

Table B25 shows that a majority of rural study participants reside in areas of high Lassa fever death rates (76.7%) while the proportion was much lower for urban study participants (22.8%). There was a statistically significant association between residence and Lassa fever deaths ($\chi^2$= 76.094, $p$<.001).

From the results shown in Table 25, the null hypothesis, which states that there is no association between residence and mortality of Lassa fever in Edo State is rejected.

## Summary

This study set out to answer three research questions that focus on the relationship between some independent variables and transmission of Lassa fever. The results of statistical analysis in this study were used to test the null hypotheses related to these research questions. First, the results of this study showed that a statistically significant relationship exist between demographic factors (specifically, residence and ethnicity) and Lassa fever transmission. Secondly, there were significant associations between socioeconomic factors (specifically, occupation, monthly household income, and housing condition) and Lassa fever transmission. Thirdly, there was a statistically significant association between residence and Lassa fever deaths. In all three RQs, the null hypotheses were rejected.

In the next chapter, I discuss the results of the study. The results are interpreted based on the literature review and in the context of the conceptual framework for this study. Finally, I discuss the social change implications and provide appropriate recommendations.

# Chapter 5: Discussion, Conclusions, and Recommendations

Repeated outbreaks of Lassa fever, a viral hemorrhagic fever, occur on a yearly basis in some states in Nigeria, including Edo State (Ochei et al., 2014; Ogoina, 2013; Saka et al., 2017). The disease, caused by LASV, is associated with significant morbidity and mortality (Akpede et al., 2019; Azeez-Akande, 2016; WHO, 2016). A Lassa fever outbreak puts a strain on the health care system and adversely affects individuals and affected communities (Asogun et al., 2016; Fatiregun & Isere, 2017). Although some references are made to sociodemographic variables in the occurrence of Lassa fever in literature (Bonner et al., 2007; Bonwitt et al., 2017; Ogbu et al., 2007; Ogoina, 2013), the influence of demographic and socioeconomic factors on the transmission of the disease has not been adequately studied.

The purpose of this dissertation was to study the relationship between demographic and socioeconomic factors and transmission of Lassa fever. A quantitative approach was adopted for this study. The study variables were studied using a cross-sectional study design (Creswell, 2014). Mostly primary data and some secondary data were used to address the research questions in this work. The study was conducted with the intention of contributing empirical evidence to the control of Lassa fever in Edo State.

The key findings in this study indicate that there are significant associations between demographic and socioeconomic factors and transmission of Lassa fever. Among the demographic variables that were considered in this work, urban residence and the Afemai and Esan ethnic groups were found to have statistically significant associations with Lassa fever transmission as demonstrated by significantly higher

prevalence of Lassa fever in in urban communities in Edo State and among the Afemai and Esan ethnic groups. In addition, regression analysis showed that rural residence was significantly predictive of low Lassa fever transmission while being in the Esan ethnic group was significantly predictive of high Lassa fever transmission.

Among socioeconomic factors considered in this research, business/trading, civil service, and working under private authority were significantly associated with transmission of Lassa fever. Furthermore, lower monthly household income and poor housing condition were shown to have statistically significant association with residing in areas with high Lassa fever transmission. Regression analysis revealed that being engaged in formal occupation (under public or private authority) and poor housing significantly decreased the odds of being resident in a low Lassa fever transmission community. These multinomial logistic regression findings mean that formal occupation and poor housing condition were significantly predictive of being resident in an area of high Lassa fever transmission. With respect to mortality rates, rural residence was demonstrated to have significant association with Lassa fever death.

## Interpretation of the Findings

This study revealed that that the highest proportions of respondents in high burden Lassa fever transmission areas were the age groups of 30–39 years and 40–49 years. The age brackets associated with being resident in communities of high Lassa fever transmission in this study is similar to the age group of 39–56 years and 26–35 years mostly associated with a positive Lassa fever test reported by other researchers (Shehu et al., 2018; Tobin et al., 2015). Also, the predilection for younger age groups found in this

study is similar to the findings of higher risk of infection with LASV in those aged 15–59 compared to older groups in a study done in Sierra Leone (Bonner et al., 2007). However, there was no significant association between age and residing in areas of high Lassa fever transmission found in this study, a finding that buttresses the reports of other authors (Kerneis et al., 2009; Ogbu et al., 2007). It is important to note that younger age groups are more physically active and engage more often in socioeconomic activities.

This study revealed that gender was not significantly associated with living in an area of high or low Lassa fever transmission though males constituted a higher proportion of Lassa fever cases. This is in contrast with the finding that female gender was significantly associated with incidence of Lassa fever in another study done in Edo State (Tobin et al., 2015) and a study done in Sierra Leone (Bonner et al., 2007). However, my finding of no significant association between gender and Lassa fever disease is in league with the works of some researchers in Nigeria and Guinea (Ilori et al., 2019; Kerneis et al., 2009) who found no significant association between gender and positive test result for Lassa fever.

There was no significant influence of marital status on Lassa fever transmission in this study. This was in contrast to a previous study done in Esan West LGA, where it was found that being presently or previously married was significantly associated with Lassa fever occurrence (Tobin et al., 2015). The reference work was a pilot study that was conducted in just one LGA and the outcome variable was Lassa fever seroprevalence. A highly significant association between urban residence and Lassa fever transmission was found in this study ($p < .001$) and household size was not significantly associated with

the disease. No other previous study has captured any information on the possible effect of household size on Lassa fever infection. In a hospital-based study, with a small sample size, conducted in Jos, Nigeria, it was found that the majority of Lassa fever cases were in urban communities, though no statistical test was carried out to test the association (Shehu et al., 2018). The finding of statistically significant association between urban residence and Lassa fever transmission in this study was in contrast to a result of no significant difference between residence and seroprevalence of Lassa fever in Guinea (Kerneis et al., 2009). The study by Kerneis et al. (2009), carried out in Guinea, relied on testing of serum obtained from study participants as against existing Lassa fever records used for this study. This difference together with the different geographical settings may have accounted for the contrast in relationship between residence and Lassa fever transmission.

It was observed in this study that ethnic group was a significant demographic factor in Lassa fever infection. The results showed that the Esan and Afemai ethnic groups were largely found in areas of high Lassa fever burden. This observation may be reflective of a coincidence of geographical distribution of human population and that of rodent population. Lassa fever prevalence have been found to be associated with distribution of *M. natalensis* (Bonwitt et al., 2017; Fichet-Calvet, 2014; Lecompte et al., 2006). Other authors have also posited that the epidemiology of Lassa fever has demonstrable links with climate as well as the geographical distribution of the *Mastomys* vector (Bonner et al., 2007; Fichet-calvet & Rogers, 2009; Gibb et al., 2017; Lecompte et al., 2006; Ogoina, 2013). It is also important to note that the Afemai and Esan people of

Edo State are mainly found in geographically distinct areas of Edo North and Edo Central districts of the state respectively (Edo State Government of Nigeria, 2017; Edo State Ministry of Health, 2018; Segynola, 2011).

In this work, occupation rather than employment status was more relevant in determining Lassa fever occurrence. Specifically, residing in high Lassa fever transmission areas was significantly associated with trading/business and with working under civil or private authority. In contrast, there was no significant association between occupation and a positive Lassa fever test in a study done in Jos, Nigeria (Shehu et al., 2018). The finding of a significant influence of occupation on Lassa fever in my study may be explainable by the dominance of trading and civil service in the study area. Another socioeconomic factor that was examined in this study was educational attainment, which was found not to have significant association with Lassa fever transmission. Among the literature reviewed for this work, only the study carried out by Tobin et al. (2015) considered education as a factor in Lassa fever transmission. They equally found no statistically association between educational attainment and Lassa fever positive sero-status.

The findings of this research indicate that lower monthly household income was associated with residing in areas of low Lassa fever transmission. This may be explained by another observation in this study that low transmission areas were mostly rural residences where the majority of households with lower income were found. Typically, however, a positive relationship between poor income and disease documented in literature (Bloom & Cadarette, 2019; CDC, 2010; Solar & Irwin, 2010). Furthermore,

household hygiene and housing conditions are largely influenced by household income among other factors (Heymann, 2006; Stevens, 2004). No previous study had specifically addressed the relationship between income and Lassa fever infection.

In this research, poor housing condition was shown to have a statistically significant association with residing in high Lassa fever transmission area. Housing conditions considered in this study included house surroundings and waste disposal. The significant association observed in this study is in agreement with the position canvased by other authors who stated that housing conditions are relevant in Lassa fever transmission (Gbakeji et al., 2016; Gibb et al., 2017). Specifically, poor housing was found to be a significant determinant of Lassa fever infection in a study done in Sierra Leone (Bonwitt et al., 2016). However, this finding was in contrast with the result of a study done in Ekpoma, Edo State, which showed that poor hygiene rather than poor housing quality had a significant influence on Lassa fever transmission (Ochei et al., 2014). .

The results of this study reveal that community rates of Lassa fever death were associated with rural residence. This is in contrast to the finding that occurrence of cases of Lassa fever was significantly associated with urban residence. No previous study has reported any association between residence and Lassa fever mortality. However, better outcomes of Lassa fever have been found to be significantly associated with shorter distance to the Lassa fever isolation and treatment facility in Edo State (Ireye et al., 2018). Ireye et al. (2018) explained that most rural communities who experience Lassa fever outbreaks are located far away from the dedicated treatment center for the disease.

The CSDH conceptual framework was used in this research work (Jayasinghe, 2015; Solar & Irwin, 2010). The framework summarizes the relationship between two sets of determinants and health. The determinants are structural (i.e., socioeconomic and political context, and socioeconomic position) and intermediary determinants (i.e., material circumstances, behavioral, psychological, and biological factors). In this study, a mix of factors in the two sets of health determinants was examined (Solar & Irwin, 2010; Zaboli et al., 2014). The results of this study revealed that some demographic and socioeconomic factors are significantly associated with Lassa fever transmission and deaths. These factors are residence, ethnicity, occupation, monthly household income, and housing condition. In the CSDH context, residence, occupation, monthly household income, and ethnicity are structural determinants while housing condition is an intermediary determinant.

The prominence of Lassa fever as an infectious disease in Nigeria in general and in some states including Edo in particular is closely related the strain posed by outbreak of the disease on human and material resources (Akpede et al., 2019; Wogu, 2018). Globally, there are also concerns that Lassa fever has a potential for being used as a bio-terrorism weapon (Mateer et al., 2018; Richmond & Baglole, 2003). These realizations in the context of recurring outbreaks have prompted concerted efforts to control the disease. An understanding of factors that may influence the transmission of the disease is important for effective interventions. The thrust of this work has been to identify demographic and socioeconomic factors relevant to Lassa fever transmission and how they contribute to the disease.

From the mix of factors considered in this work, residence stood out as a critical demographic factor in Lassa fever transmission. While the analysis showed that urban residence was an important predictor of Lassa fever transmission, rural residence was rather associated with Lassa fever deaths. The model applied to the socioeconomic factors revealed the importance of housing in Lassa fever outbreaks. Housing conditions may also be related to type of residence and may reflect waste control practices that affect rodent breeding (Aigbiremolen et al., 2017; Gbakeji et al., 2016; Ochei et al., 2014).

## Limitations of the Study

Some of the respondents in this study were previously diagnosed cases of Lassa fever. Due to the stigma associated with the disease, some of such respondents were initially reluctant to participate in the study. However, following assurance of confidentiality and explanation of the benefits of the study to the control of Lassa fever, concerns about stigma were laid to rest for most of such hesitant respondents. The COVID-19 pandemic caused restrictions of meetings and visits to homes of respondents. However, COVID-19 safety protocols were followed to interact with the study participants. If the protocol had permitted interview of respondents in their homes, I would have been able to confirm the responses that were given concerning housing conditions and be surer that the respondents' answers to the questions were based on good understanding.

In this study, Lassa fever transmission was measured by using burden of cases of Lassa fever (confirmed/reported cases). A better measure would have been recent

seroprevalence studies (Yun & Walker, 2012), which were not available. Seroprevalence data includes evidence of infection in both symptomatic and asymptomatic persons who have the humoral markers of infection (Bausch et al., 2001; Gibb et al., 2017). Also, children were excluded from this study, whereas the reference data from Edo State Ministry of Health that was used to classify transmission of Lassa fever into low, medium, and high burden areas included cases of all age groups (Edo State Ministry of Health, 2020). These limitations affect the generalizability of the findings of this study.

This study employed a cross-sectional design, which is not able to fulfill important criteria for the determination of causality (Carlson & Morrison, 2009; Habib et al., 2014). In addition, a larger and more diverse sample size would have improved the generalizability of the findings of this study, considering that there are other high burden States in Nigeria with different sociodemographic features. The presence of a national Lassa fever reference laboratory and specialized treatment center may have created a hub of influence that modify the morbidity and mortality profile of Lassa fever cases in the state. Overall, the findings of this study are expected to support the generation of further research questions.

## Recommendations

This study found that some demographic and socioeconomic factors are significantly linked to Lassa fever transmission. The disease is significantly associated with urban residence and poor housing condition. I recommend that greater attention should be paid by government and partners to urban communities in Lassa fever control activities such as risk communication and other community engagements. Meanwhile,

researchers may consider conducting longitudinal studies and randomized controlled trials to further determining the extent of these and related factors in Lassa fever control. Promotion of better housing through economic empowerment, people-friendly housing regulations, and government-funded housing schemes may be undertaken by both local and national governments to ensure residents have access to better housing conditions.

Household income, some occupations, and some ethnic groups were demonstrated to have significant relationships with Lassa fever transmission in this work. I recommend that the government implement policies geared towards socioeconomic empowerment of the citizens of Edo State through supported education and provision of employment opportunities to improve household income of the people. During Lassa fever campaign activities, there should be targeted messaging for people with lower socioeconomic status, including farmers and civil servants. It will also be strategic to intensify prevention programs such as deratization, environmental sanitation, and household hygiene promotion among the Afemai and Esan people where Lassa fever transmission is significantly higher than other tribes.

## Implications for Positive Social Change

The findings of the study may contribute positively to social change. The empirical evidence on the determinants of Lassa fever provided in this study can enhance health promotion activities aimed at the prevention of Lassa fever. Advocacy (based on empirical evidence from this dissertation) to community leaders and relevant government officials and agencies may serve to awaken the motivation to provide economic empowerment programs and implement better policies for the good of residents and

particularly for indigent community members as a way of enhancing their ability to protect themselves from Lassa fever and other endemic diseases.

## Conclusion

Lassa fever control can be improved with better understanding of important factors relevant to its transmission. By the outcome of this study, urban residence, formal occupation, poor housing conditions, and ethnicity are significant predictors of Lassa fever transmission in Edo State. In addition, residence in rural area was associated with high Lassa death rates. This study has shown that demographic and socioeconomic factors are significant factors in the transmission of the disease. These factors, as captured in the CSDH framework, are considered to be interrelated in their influence on disease outcomes. In essence, Lassa fever transmission and mortality are influenced by some known determinants of health.

# References

Achinge, G. I., Kur, J. T., & Gyoh, S. K. (2013). Lassa fever Outbreak in Makurdi, North Central Nigeria: what you need to know. *IOSR Journal of Dental and Medical Sciences*, *7*(5), 42–46. https://doi.org/10.9790/0853-0754246

Adewuyi, G. M., Fowotade, A., & Adewuyi, B. T. (2009). Lassa fever: Another infectious menace. *African Journal of Clinical and Experimental Microbiology*, *10*(3), 144–155. https://doi.org/10.4314/ajcem.v10i3.43407

Aigbiremolen, A. O., Duru, C., Awunor, N., Abejegah, C., Abah, S., Asogun, A., & Eguavoen, O. (2012). Knowledge and application of infectious disease control measures among primary care workers in Nigeria: the Lassa Fever Example. *International Journal of Basic, Applied and Innovative Research*, *1*(4), 122–129.

Aigbiremolen, A. O., Ejiyere, H. O., Abejegah, C., Asalu, O., Abah, S., Edeawe, P. E., & Lawal-Luka, R. (2013). Awareness and practice regarding Lassa fever in endemic rural communities in Edo State, Nigeria. *Annals of Medical Research*, *4*(June), 12–20.

Aigbiremolen, A. O., Lawal-Luka, R. K., Abejegah, C., Aigberemwon, J. A., Abah, E. O., & Abah, S. O. (2017). Environmental risk factors in the transmission of Lassa fever in college students' hostels in Ekpoma, a semi urban town in South- South Nigeria. *Annals of Rural and Sub-Urban Medicine*, *3*(1), 37–43.

Akpede, G. O., Asogun, D. A., Okogbenin, S. A., Dawodu, S. O., Momoh, M. O., Dongo, A. E., Ike, C., Tobin, E., Akpede, N., Ogbaini-Emovon, E., Adewale, A. E., Ochei, O., Onyeke, F., Okonofua, M. O., Atafo, R. O., Odia, I., Adomeh, D. I.,

Odigie, G., Ogbeifun, C., … Agbonlahor, D. E. (2019). Caseload and case fatality of Lassa fever in Nigeria, 2001-2018: A specialist center's experience and its implications. *Frontiers in Public Health*, *7*(6), 2001–2018. https://doi.org/10.3389/fpubh.2019.00170

Asogun, D., Okokhere, P., Okogbenin, S., Akpede, G., Gunther, S., & Happi, C. (2010). Lassa fever awareness and practices in a Nigerian rural community. *Int Journal of Infectious Diseases*, *2*(19), 50–55. https://doi.org/10.1016/j.ijid.2010.02.1950

Asogun, D., Tobi, E., Momoh, J., Ochei, O., Ogbetere, Y., Shehu, L., & Ufua. F. (2016). Medical Cost of Lassa Fever Treatment in Irrua Specialist Teaching Hospital, Nigeria. *International Journal of Basic, Applied and Innovative Research*, *5*(3), 62–73.

Awosanya, E. J. (2018). Post-epidemic awareness and knowledge of Lassa fever among residents in affected community in Ibadan, Oyo State, Nigeria. *Veterinary World*, *11*(8), 1059–1063. https://doi.org/10.14202/vetworld.2018.1059-1063

Azeez-Akande, O. (2016). A review of Lassa fever, an emerging old world haemorrhagic viral disease in Sub-Saharan Africa. *African Journal of Clinical and Experimental Microbiology*, *17*(4), 282–289. https://doi.org/10.4314/ajcem.v17i4.9

Bausch, D. G., Demby, A. H., Coulibaly, M., Kanu, J., Goba, A., Bah, A., Conde, N., Wurtzel, H. L., Cavallaro, K. F., Lloyd, E., Baldet, F. B., Cisse, S. D., Fofona, D., Savane, I. K., Tolno, R. T., Mahy, B., Wagoner, K. D., Ksiazek, T. G., Peters, C. J., & Rollin, P. E. (2001). Lassa fever in Guinea: I. Epidemiology of human disease and clinical observations. *Vector Borne Zoonotic Dis*, *1*(4), 269–281.

https://doi.org/10.1089/15303660160025903

Bausch, D. G., Rollin, P. E., Demby, A. H., Coulibaly, M., Kanu, J., Conteh, A. S., Wagoner, K. D., Mullan, L. K. M. C., Bowen, M. D., Peters, C. J., & Ksiazek, T. G. (2000). Diagnosis and clinical virology of Lassa fever as evaluated by enzyme-linked immunosorbent assay, indirect fluorescent- antibody test, and virus isolation. *Journal of Clinical Microbiology*, *38*(7), 2670–2677. https://doi.org/10.1128/jcm.38.7.2670-2677.2000

Bayaga, A. (2010). Multinomial logistic regression: Usage and application in risk analysis. *Journal of Applied Quantitative Methods*, *5*(2), 288–297.

Blane, D. (1995). Social determinants of health- socioeconomic status, social class, and ethnicity. *American Journal of Public Health*, *85*(7), 903–905. https://doi.org/10.2105/ajph.85.7.903

Bloom, D. E., & Cadarette, D. (2019). Infectious disease threats in the twenty-first century: Strengthening the global response. *Frontiers in Immunology*, *10*(549), 1–12. https://doi.org/10.3389/fimmu.2019.00549

Bond, N., Schieffelin, J. S., Moses, L. M., Bennett, A. J., & Bausch, D. G. (2013). A historical look at the first reported cases of Lassa fever: IgG antibodies 40 years after acute infection. *American Journal of Tropical Medicine and Hygiene*, *88*(2), 241–244. https://doi.org/10.4269/ajtmh.2012.12-0466

Bonner, P. C., Schmidt, W. P., Belmain, S. R., Oshin, B., Baglole, D., & Borchert, M. (2007). Poor housing quality increases risk of rodent infestation and Lassa fever in refugee camps of Sierra Leone. *American Journal of Tropical Medicine and*

*Hygiene*, *77*(1), 169–175. https://doi.org/10.4269/ajtmh.2007.77.169

Bonwitt, J., Kelly, A. H., Ansumana, R., Agbla, S., Sahr, F., Saez, A. M., Borchert, M., Kock, R., & Fichet-Calvet, E. (2016). Rat-atouille: a mixed method study to characterize rodent hunting and consumption in the context of Lassa fever. *EcoHealth*, *13*(2), 234–247. https://doi.org/10.1007/s10393-016-1098-8

Bonwitt, J., Sáez, A. M., Lamin, J., Ansumana, R., Dawson, M., Buanie, J., Lamin, J., Sondufu, D., Borchert, M., Sahr, F., Fichet-Calvet, E., & Brown, H. (2017). At home with mastomys and rattus: Human-rodent interactions and potential for primary transmission of Lassa virus in domestic spaces. *American Journal of Tropical Medicine and Hygiene*, *96*(4). https://doi.org/10.4269/ajtmh.16-0675

Boutayeb, A. (2010). The Impact of Infectious Diseases on the Development of Africa. In *Handbook of Disease Burdens and Quality of Life Measures.* Springer.

Buba, M. I., Dalhat, M. M., Nguku, P. M., Waziri, N., Mohammad, J. O., Bomoi, I. M., Onyiah, A. P., Onwujei, J., Balogun, M. S., Bashorun, A. T., Nsubuga, P., & Nasidi, A. (2018). Mortality among confirmed Lassa fever cases during the 2015–2016 outbreak in Nigeria. *American Journal of Public Health*, *108*(2), 262–264. https://doi.org/10.2105/AJPH.2017.304186

Bursac, Z., Gauss, C. H., Williams, D. K., & Hosmer, D. W. (2008). Purposeful selection of variables in logistic regression. *Source Code for Biology and Medicine*, *3*(17), 1–8. https://doi.org/10.1186/1751-0473-3-17

Carlson, M. D. A., & Morrison, R. S. (2009). Study design, precision, and validity in observational studies. *Journal of Palliative Medicine*, *12*(1), 77–82.

https://doi.org/10.1089/jpm.2008.9690

Centers for Disease Control and Prevention. (2010). *Establishing a holistic framework to reduce inequities in HIV, viral hepatitis, STDs, and tuberculosis in the United States*. https://www.cdc.gov/socialdeterminants/docs/SDH-White-Paper-2010.pdf

Chowdhury, M. Z. I., & Turin, T. C. (2020). Variable selection strategies and its importance in clinical prediction modelling. *Family Medicine and Community Health*, *8*(1), 1–7. https://doi.org/10.1136/fmch-2019-000262

Cochran, G. W. (1963). *Sampling techniques* (2nd ed.). John Wiley and Sons.

Creswell, J. W. (2009). *Research design: qualitative, quantitative and mixed method approaches* (3rd ed.). Sage Publications.

Creswell, J. W. (2014). *Research design: qualitative, quantitative, and mixed methods approaches*. Sage Publications.

Dahmane, A., van Griensven, J., Van Herp, M., Van den Bergh, R., Nzomukunda, Y., Prior, J., Alders, P., Jambai, A., & Zachariah, R. (2014). Constraints in the diagnosis and treatment of Lassa fever and the effect on mortality in hospitalized children and women with obstetric conditions in a rural district hospital in Sierra Leone. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *108*(3), 126–132. https://doi.org/10.1093/trstmh/tru009

Dan-Nwafor, C. C., Furuse, Y., Ilori, E. A., Ipadeola, O., Akabike, K. O., Ahumibe, A., Okoli, I., Okea, R. A., Makava, F., Ugbogulu, N., Oladele, S., Namara, G., Muwanguzi, E. N., Lasuba, C. L., & Ihekweazu, C. (2019). Measures to control protracted large Lassa fever outbreak in Nigeria, 1 January to 28 April 2019. *Euro*

*Suveill.*, *24*(20), 1–4. https://doi.org/10.2807/1560-7917.es.2019.24.20.1900272

Dan-Nwafor, C. C., Ipadeola, O., Smout, E., Ilori, E., Adeyemo, A., Umeokonkwo, C., Nwidi, D., Nwachukwu, W., Ukponu, W., Omabe, E., Anaebonam, U., Igwenyi, N., Igbodo, G., Eteng, W., Uzoma, I., Saleh, M., Agboeze, J., Mutbam, S., de Gooyer, T., … Ihekweazu, C. (2019). A cluster of nosocomial Lassa fever cases in a tertiary health facility in Nigeria: description and lessons learned, 2018. *International Journal of Infectious Diseases*, *83*, 88–94. https://doi.org/10.1016/j.ijid.2019.03.030

Davis, F. G., Peterson, C. E., Bandiera, F., Carter-Pokras, O., & Brownson, R. C. (2017). How do we more effectively move epidemiology into policy action? *Ann Epidemiol.*, *263*(2), 219–227. https://doi.org/10.1097/SLA.0000000000001177

Dean, H. D., & Fenton, K. A. (2010). Addressing social determinants of health in the prevention and control of HIV/AIDS, viral hepatitis, sexually transmitted infections, and tuberculosis. *Public Health Reports*, *125*(S4), 1–5. https://doi.org/10.1177/00333549101250s401

Dean, H. D., & Fenton, K. A. (2013). Integrating a Social Determinants of Health approach into public health practice: A five-year perspective of actions implemented by CDC's National Center for HIV/AIDS, Viral Hepatitis, STD and TB Prevention. *Public Health Reports*, *128*(S3), 5–11. https://doi.org/10.1177/00333549131286s302

Degl'Innocenti, A., Guyatt, G. H., Wiklund, I., Heels-Ansdell, D., Armstrong, D., Fallone, C. A., Tanser, L., van Zanten, S. V., El-Dika, S., Chiba, N., Barkun, A.

N., Austin, P., & Schünemann, H. J. (2005). The influence of demographic factors and health-related quality of life on treatment satisfaction in patients with gastroesophageal reflux disease treated with esomeprazole. *Health and Quality of Life Outcomes*, *3*(4), 1–8. https://doi.org/10.1186/1477-7525-3-4

Disha, M. (2019). *Chi-square test: meaning, applications and uses*. http://www.yourarticlelibrary.com/project-reports/chi-square-test/chi-square-test-meaning-applications-and-uses-statistics/92394

du Prel, J.-B., Röhrig, B., Hommel, G., & Blettner, M. (2010). Choosing statistical tests. *Deutsches Ärzteblatt International*, *107*(19), 343–348. https://doi.org/10.3238/arztebl.2010.0343

Edo State Government of Nigeria. (2017). *Edo people*. http://www.edostate.gov.ng/edo-people/

Edo State Ministry of Health. (2018). *Edo State Strategic Health Development Plan II: Towards actualizing the provision of basic health care services*. Edo State Government.

Edo State Ministry of Health. (2020). *Lassa fever surveillance register*. Edo State Government.

Ehichioya, D. U., Asogun, D. A., Ehimuan, J., Okokhere, P. O., Pahlmann, M., Ölschläger, S., Becker-Ziaja, B., Günther, S., & Omilabu, S. A. (2012). Hospital-based surveillance for Lassa fever in Edo State, Nigeria, 2005-2008. *Tropical Medicine and International Health*, *17*(8), 1001–1004. https://doi.org/10.1111/j.1365-3156.2012.03010.x

Eze, K. C., Salami, T. A. T., Eze, I. C., Pogoson, A. E., Omordia, N., & Ugochukwu, M. O. (2010). High Lassa fever activity in northern part of Edo State, Nigeria: re-analysis of confirmatory test results. *Afr J Health Sci*, *17*(3), 52–56.

Fatiregun, A., & Isere, E. E. (2017). Epidemic preparedness and management: a guide on Lassa fever outbreak preparedness plan. In *Nigerian Medical Journal* (Vol. 58, Issue 1, pp. 1–6). https://doi.org/10.4103/0300-1652.218414

Fichet-Calvet, E. (2014). Lassa fever. In *The role of animals in emerging viral diseases* (pp. 89–123). https://doi.org/10.1016/B978-0-12-405191-1.00005-3

Fichet-calvet, E., & Rogers, D. J. (2009). Risk maps of Lassa fever in West Africa. *PLoS Neglected Tropical Diseases*, *3*(3), e388. https://doi.org/10.1371/journal.pntd.0000388

Friel, S., & Marmot, M. (2011). Action on the social determinants of health and health inequities goes global. *Annu. Rev. Public Health*, *32*(1), 225-236. https://doi.org/10.1146/annurev-publhealth-031210-101220

Gbakeji, J. O., Aigbiremolen, A. O., & Rilwani, M. L. (2016). Housing quality and vector control: utilizing an effective strategy against common disease vectors. *International Journal of Environmental Studies and Safety Research*, *1*(3), 81–88.

Gibb, R., Moses, L. M., Redding, D. W., & Jones, K. E. (2017). Understanding the cryptic nature of Lassa fever in West Africa. *Pathogens and Global Health*, *111*(6), 276–288. https://doi.org/10.1080/20477724.2017.1369643

Glass, T., Goodman, S., Hernán, M. A., & Samet, J. (2013). Causal inference in public health. *National Institutes of Health*, *34*, 61–75. https://doi.org/10.1146/annurev-

publhealth-031811-124606

Gobir, A. A., Ejembi, C. ladi, Aliyu, A., Garba, B. M., Igboanusi, C., Usman, B., Umar, Z., & Joshua, I. (2019). Hygiene practices in a Nigerian rural community during Lassa fever epidemic. *Saudi Journal of Medicine & Medical Sciences*, *7*(2), 121–123. https://doi.org/10.4103/sjmms.sjmms_192_18

Habib, A., Johargy, A., & Mahmood, K. (2014). Design and determination of the sample size in medical research. *IOSR Journal of Dental and Medical Sciences Ver. VI*, *13*(5), 2279–2286. https://doi.org/10.9790/0853-13562131

Hamblion, E. L., Raftery, P., Wendland, A., Dweh, E., Williams, G. S., George, R. N. C., Soro, L., Katawera, V., Clement, P., Gasasira, A. N., Musa, E., & Nagbe, T. K. (2018). The challenges of detecting and responding to a Lassa fever outbreak in an Ebola-affected setting. *International Journal of Infectious Diseases*, *66*, 65–73. https://doi.org/10.1016/j.ijid.2017.11.007

Heymann, D. L. (2006). *Effects of social, environmental and economic factors on current and future patterns of infectious diseases:interactions between global change and human health.* Pontifical Academy of Sciences. http://www.pas.va/content/dam/accademia/pdf/sv106/sv106-heymann.pdf

Hosmer, D. W., & Lemeshow, S. (2000). Applied logistic regression. In *Wiley series in probability and statistics* (2nd ed.). Wiley-Intercience Publication. https://doi.org/10.2307/2532419

Houlihan, C., & Behrens, R. (1986). Lassa fever. *BMJ*, *2017*(358), j2986. https://doi.org/10.1136/bmj.j2986

Ilori, E. A., Furuse, Y., Ipadeola, O. B., Dan-nwafor, C. C., Abubakar, A., Womi-eteng, O. E., Ogbaini-emovon, E., Okogbenin, S., Unigwe, U., Ogah, E., Ayodeji, O., Abejegah, C., Liasu, A. A., Musa, E. O., Woldetsadik, S. F., & Lasuba, C. L. P. (2019). Epidemiologic and clinical features of Lassa fever outbreak in Nigeria, January 1-May 6, 2018. *Emerg Infect Dis*, *25*(6), 1066–1074. https://doi.org/10.3201/eid2506.181035

International Business Machines. (2020). *Statistical Package for Social Sciences (SPSS)* (No. 26). IBM.

Ireye, F., Aigbiremolen, A. O., Mutbam, K. S., Okudo, I., Famiyesin, E. O., Asogun, D., Braka, F., Irowa, O., Abubakar, A., Iretoi, G., & Ejiyere, H. (2018). An assessment of onset-to-intervention time and outcome of Lassa fever during an outbreak in Edo State , Nigeria. *International Journal of Prevention and Treatment*, *7*(1), 1–5. https://doi.org/10.5923/j.ijpt.20180701.01

Ireye, F., Ejiyere, H., Aigbiremolen, A. O., Famiyesin, O. E., Rowland-Udoh, E. A., Ogeyemhe, C. O., Okudo, I., & Onimisi, A. B. (2019). Knowledge, attitude and infection prevention and control practices regarding Lassa fever among healthcare workers in Edo State, Nigeria. *International Journal of Prevention and Treatment*, *8*(1), 21–27. https://doi.org/10.5923/j.ijpt.20190801.03

Jayasinghe, S. (2015). Social determinants of health inequalities: towards a theoretical perspective using systems science. *International Journal for Equity in Health*, *14*(1), 1–8. https://doi.org/10.1186/s12939-015-0205-8

Kaare, S., Chowdhury, N., & Kazi, V. (2007). *The power of evidence in advocacy*.

Overseas Develeopment Institute (Britain). https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/251.pdf

Kasiulevičius, V., Šapoka, V., & Filipavičiūtė, R. (2006). Sample size calculation in epidemiological studies. *Gerontologija, 7*(4), 225–231.

Kelly, A. P. (2011). *Social research methods* (2nd ed.). University of London.

Kerneis, S., Koivogui, L., Magassouba, N. F., Koulemou, K., Lewis, R., Aplogan, A., Grais, R. F., Guerin, P. J., & Fichet-Calvet, E. (2009). Prevalence and risk factors of Lassa seropositivity in inhabitants of the Forest Region of Guinea: a cross-sectional study. *PLoS Neglected Tropical Diseases*, *3*(11), e548. https://doi.org/10.1371/journal.pntd.0000548

Laerd Statistics. (2013). *How to perform a multinomial logistic regression in SPSS statistics*. https://statistics.laerd.com/spss-tutorials/multinomial-logistic-regression-using-spss-statistics.php

Laerd Statistics. (2018). *Chi-square test for association using SPSS statistics*. https://statistics.laerd.com/spss-tutorials/chi-square-test-for-association-using-spss-statistics.php

Lecompte, E., Fichet-Calvet, E., Daffis, S., Koulémou, K., Sylla, O., Kourouma, F., Doré, A., Soropogui, B., Aniskin, V., Allali, B., Kan, S. K., Lalis, A., Koivogui, L., Günther, S., Denys, C., & Ter Meulen, J. (2006). *Mastomys natalensis* and Lassa fever, West Africa. *Emerging Infectious Diseases*, *12*(12), 1971–1974. https://doi.org/10.3201/eid1212.060812

Lucas, R. (2012). Frameworks for causal inference in epidemiology. In N. Lunet (Ed.), *Epidemiology- Current Perspectives on Research and Practice* (pp. 13–30). InTech. https://doi.org/10.5772/32009

Målqvist, M., Hoa, D. T. P., & Thomsen, S. (2012). Causes and determinants of inequity in maternal and child health in Vietnam. *BMC Public Health*, *12*(1). https://doi.org/10.1186/1471-2458-12-641

Mann, C. J. (2003). Observational research methods research design II: cohort, cross sectional, and case-control studies. *Emergency Medicine Journal*, *20*(1), 54–60. https://doi.org/10.1136/emj.20.1.54

Mateer, E. J., Huang, C., Shehu, N. Y., & Paessler, S. (2018). Lassa fever–induced sensorineural hearing loss: a neglected public health and social burden. *PLoS Neglected Tropical Diseases*, *12*(2), 1–11. https://doi.org/10.1371/journal.pntd.0006187

MEASURE Evaluation. (2015). *Health service access*. RBF Indicator Compendium. https://www.measureevaluation.org/rbf/indicator-collections/structural-indicators/health-service-access

Muanya, C. (2016, January 10). Poor hygiene, poverty, ignorance fuel Lassa fever epidemic in Nigeria. *The Gaurdian*. http://guardian.ng/sunday-magazine/poor-hygiene-poverty-ignorance-fuel-lassa-fever-epidemic-in-nigeria/

Nigeria Centre for Disease Control. (2018). *2018 Lassa fever outbreak in Nigeria Epi-Week 19*. Federal Ministry of Health.

Nigeria Centre for Disease Control. (2019a). *2019 Lassa fever outbreak situation report*,

*Epi-Week 50*.

Nigeria Centre for Disease Control. (2019b). *An update of Lassa fever outbreak in Nigeria for Week 52, 2018*. NCDC.

Nigeria Centre for Disease Control. (2020). *Implementation guidelines for containment of COVID-19*. https://covid19.ncdc.gov.ng/guideline/

Nwonwu, E. U., Alo, C., Una, A. F., Madubueze, U. C., Eze, I., Eze, N. C., Ogbonnaya, L. U., & Akamike, I. C. (2018). Knowledge of Lassa fever and its determinants among traders in Izzi community in. *Archives of Current Research International*, *13*(4), 1–9. https://doi.org/10.9734/ACRI/2018/39904

Ochei, O., Abejegah, C., Okoh, E., & Abah, S. O. (2014). Housing factors and transmission of Lassa fever in a rural area of south-south Nigeria. *General Health and Medical Sciences*, *1*(2), 15–20.

Ogbonna, C. (2014). *The basics in biostatistics, medical informatics and research methodolgy*. Yakson Printing Press.

Ogbu, O., Ajuluchukwu, E., & Uneke, C. J. (2007). Lassa fever in West African sub-region: an overview. *Journal of Vector Borne Diseases*, *44*(1), 1–11.

Ogoina, D. (2013). Lassa Fever: a clinical and epidemiological review. *Niger Delta Journal of Medicine and Medical Research*, *1*(1).

Ogwuche, P., Onemolease, E. A., Umar, H. ., & Igbinosa, F. (2016). Analyses of farmers' level of awareness of improved rubber technologies in Edo State, Nigeria. *Direct Research Journal of Agriculture and Food Science*, *4*(4), 60–65.

Ojeifo, O. M., & Eseigbe, J. O. (2012). Categorization of urban centres in Edo State,

Nigeria. *IOSR Journal of Business and Management (IOSRJBM)*, *3*(6), 111–120.

Onah, I. S., Collins, O. C., Madueme, P. G. U., & Mbah, G. C. E. (2020). Dynamical system analysis and optimal control measures of Lassa fever disease model. *International Journal of Mathematics and Mathematical Sciences*, *2020*, 1–18. https://doi.org/10.1155/2020/7923125

Richmond, J. K., & Baglole, D. J. (2003). Lassa fever: epidemiology, clinical features, and social consequences. *BMJ*, *327*, 1271–1275. https://doi.org/10.1136/bmj.327.7426.1271

Rothman, K. J., & Greenland, S. (2005). Hill's criteria for causality. *Encyclopedia of Biostatistics*. https://doi.org/10.1002/0470011815.b2a03072

Sabin, C. A. (2012). *What are observational studies and how do they differ from clinical trials?* http://www.ukcab.net/wp-content/uploads/2012/07/UKCHIC-Cohort-studies.pdf

Saez, A. M., Haidara, M. C., Camara, A., Kourouma, F., Sage, M., Magassouba, N., & Fichet-Calvet, E. (2018). Rodent control to fight Lassa fever: evaluation and lessons learned from a 4-year study in Upper Guinea. *PLoS Neglected Tropical Diseases*, *12*(11), e0006829. https://doi.org/10.6084/m9.figshare.5545267

Saka, J. M., Bintu Gubio, A., Kerecvel, Y. S., Saka, A. O., & Oyemakinde, A. (2017). Lassa fever epidemic in Nigeria- outbreak investigation, risk factors and empirical analysis from 2012 To 2016. *Journal of Community & Public Health Nursing*, *03*(02). https://doi.org/10.4172/2471-9846.1000170

Schutt, R. K. (2011). *Investigating the social world: the process and practice of research*

(7th ed.). Sage Publishers. https://doi.org/10.1080/09502389300490051

Segynola, A. A. (2011). *Geographical regions of Edo State*. Ambrose Alli University Press.

Shehu, N. Y., Gomerep, S. S., Isa, S. E., Iraoyah, K. O., Mafuka, J., Bitrus, N., Dachom, M. C., Ogwuche, J. E., Onukak, A. E., Onyedibe, K. I., Ogbaini-emovon, E., Egah, D. Z., Mateer, E. J., & Paessler, S. (2018). Lassa fever 2016 outbreak in Plateau State, Nigeria — the changing epidemiology and clinical presentation. *Frontiers in Public Health*, *6*(232), 1–5. https://doi.org/10.3389/fpubh.2018.00232

Solar, O., & Irwin, A. (2010). *A conceptual framework for action on the social determinants of health*. World Health Organization. https://www.who.int/sdhconference/resources/ConceptualframeworkforactiononSDH_eng.pdf

Stevens, P. (2004). *Diseases of poverty and the 10/90 gap*. International Policy Network. https://npin.cdc.gov/publication/diseases-poverty-and-1090-gap

Stoltzfus, J. C. (2011). Logistic regression: a brief primer. *Academic Emergency Medicine*, *18*(10), 1099–1104. https://doi.org/10.1111/j.1553-2712.2011.01185.x

Suhrcke, M., Stuckler, D., Suk, J. E., Desai, M., Senek, M., Mckee, M., Tsolova, S., Basu, S., Abubakar, I., Hunter, P., Rechel, B., & Semenza, J. C. (2011). The impact of economic crises on communicable disease transmission and control: a systematic review of the evidence. *PLoS ONE*, *6*(6), e20724. https://doi.org/10.1371/journal.pone.0020724

Tambo, E., Adetunde, O. T., & Olalubi, O. A. (2018). Re-emerging Lassa fever outbreaks in Nigeria: re-enforcing “One Health” community surveillance and emergency response practice. *Infectious Diseases of Poverty*, *7*(1), 1–7. https://doi.org/10.1186/s40249-018-0421-8

Tarsi, K., & Tuff, T. (2012). Introduction to population demographics. *Nature Education Knowledge*, *3*(11), 3.

Thairu, Y., & Egenti, N. (2015). Understanding Lassa fever virus and diversification of the rodent vector in the tropics. *International Journal of Current Medical Research*, *4*(6), 372–378.

Tobin, E., Asogun, D., Akpede, N., Adomeh, D., Odia, I., & Gunther, S. (2015). Lassa fever in Nigeria: insights into seroprevalence and risk factors in rural Edo State: a pilot study. *Journal of Medicine in the Tropics*, *17*(2), 51. https://doi.org/10.4103/2276-7096.162258

Tobin, E A, Asogun, D. A., Isah, E. C., Ugege, O. G., & Ebhodaghe, P. (2013). Assessment of knowledge and attitude towards Lassa fever among primary care providers in an endemic suburban community of Edo state: implications for control. *Journal of Medicine and Medical Sciences*, *4*(8), 311–318. https://doi.org/10.14303/jmms.2013.095

Walden University. (2018). *Dissertation Guidebook*. Walden University.

Wogu, J. O. (2018). Mass media awareness campaign and the prevention of the spread of Lassa fever in the rural communities of Ebonyi State , Nigeria : *J Public Health Africa*, *9*(882), 179–184. https://doi.org/10.4081/jphia.2018.882

Wolff, S., Schultze, T., Fehling, S. K., Mengel, J. P., Kann, G., Wolf, T., Eickmann, M., Becker, S., Hain, T., & Strecker, T. (2016). Genome sequence of Lassa virus isolated from the first domestically acquired case in Germany. *Genome Announcements*, *4*(5), 5–6. https://doi.org/10.1128/genomea.00938-16

Wong, W. C. W., Cheung, S., Miu, H. Y. H., Chen, J., Loper, K. A., & Holroyd, E. (2017). Mental health of African asylum-seekers and refugees in Hong Kong: using the social determinants of health framework. *BMC Public Health*, *17*(1), 1–9. https://doi.org/10.1186/s12889-016-3953-5

Woods, E. H. (2015). *A Phenomenological study of female gender inequality in the defense industry*. Walden University ScholarWorks.

World Health Organization. (2015). *Global reference list of 100 core health indicators* (Issue 1779). https://doi.org/WHO/HIS/HSI/2015.3

World Health Organization. (2016). *Lassa Fever – Nigeria*. Emergencies Preparedness and Response. http://www.who.int/csr/don/27-may-2016-lassa-fever-nigeria/en/

World Health Organization. (2017). *Probability sampling methods for quantitative studies*. http://apps.who.int/medicinedocs/en/d/Js6169e/7.4.html

World Health Organization. (2018). *Ethical standards and procedures for research with human beings*. Ethics and Health. http://www.who.int/ethics/research/en/

World Health Organization. (2018). *Lassa fever- Nigeria*. Disease Outbreak News. http://www.who.int/csr/don/20-april-2018-lassa-fever-nigeria/en/

Yaghmaie, F. (2003). Content validity and its estimation. *Journal of Medical Education*, *3*(1), 25–27. https://doi.org/10.22037/jme.v3i1.870

Yun, N. E., & Walker, D. H. (2012). Pathogenesis of Lassa fever. *Viruses*, *4*(1), 2031–2048.

Zaboli, R., Tourani, S., Seyedin, S. H., & Oliaie Manesh, A. (2014). Prioritizing the determinants of social-health inequality in Iran: a multiple attribute decision making application. *Iranian Red Crescent Medical Journal*, *16*(4). https://doi.org/10.5812/ircmj.12607

Zamanzadeh, V., Ghahramanian, A., Rassouli, M., Abbaszadeh, A., Alavi-Majd, H., & Nikanfar, A.-R. (2015). Design and implementation content validity study: development of an instrument for measuring patient-centered communication. *Journal of Caring Sciences*, *4*(2), 165–178. https://doi.org/10.15171/jcs.2015.017

Appendix A: Questionnaire

**Questionnaire for a Study on Demographic and Socioeconomic Determinants of Lassa Fever in Edo State, Nigeria**

Participant No.: _____ Settlement: _____ Ward: _____ LGA: _____

**Introduction**: I am a PHD student of Public Health at Walden University, USA. I am carrying out a study to determine demographic and socioeconomic factors affecting the transmission of Lassa fever in Edo State. I would like to seek your responses to my questionnaire that has been approved for the study. Your answers will be handled with utmost confidentiality and used only for the purpose of this study. Thank you.

**Demographic Characteristics of Participants**

1. Age as at last birthday (in years): ……
2. Gender: Male [ ] Female [ ]
3. What is your marital status? Single [ ]; Married [ ]; Divorced/Separated [ ]; Widowed [ ].
4. What is the size of your household (the total number of persons feeding from the same kitchen as you)? ……
5. What is the geographical nature of your community? Rural [ ]; Urban [ ]
6. What is your ethnic group? ……

**Socioeconomic Factors**

7. What is your employment status? Self-employed [ ]; Employed under private or public authority [ ]; Unemployed [ ].

8. What is your current occupation?

   …….

9. What was your major occupation in the last 2 years?

   ……..

10. What is your average monthly personal income? ₦ ……

    (……...USD)

11. What is your average monthly household income? ₦ ……

    (……USD)

12. What is your highest level of education? No formal education [ ]; Primary [ ]; Secondary [ ]; Tertiary [ ].

13. A functional health facility is one having healthcare workers and basic equipment and drugs. Is there a functional health facility in your community? Yes [ ]; No [ ]

14. If you answered yes to the last question, what type of health facility is in your community? Primary health center [ ]; General Hospital [ ]; Private Hospital [ ]; Tertiary health facility (e.g. teaching or a specialist hospital) [ ].

15. What is the distance between your house and the nearest health facility? Less than or up to 5 km [ ]; More than 5 km [ ]; Not sure [ ].

16. What kind of house do you live in? Mud/thatch house [ ]; Brick house [ ]; Other (specify) _____

17. Are there rodent entry points (openings in the walls, door, windows or roof) in your house? Yes [ ]; No [ ]; Not sure [ ].

18. If yes to the question above, how many such entry points have you observed in your house? _____

19. Are there open waste bins or open dump sites in your surroundings? Yes [ ]; No [ ].

20. What is the condition of your surroundings? Well kempt [ ]; Littered [ ]; Bushy [ ].

**Occurrence of Lassa fever and Death from Lassa fever**

21. Have you been diagnosed as a case of Lassa fever within the last 2 years? Yes [ ]; No [ ]

22. If yes to question 21, when were you diagnosed? Less than 6 months ago [ ]; 6 to12 months ago [ ]; Over 12 months ago [ ].

23. Are there other persons in your household or residence that had Lassa fever within the last 2 years? Yes [ ]; No [ ]; Not sure [ ].

24. Has anyone died of Lassa fever in your house within the last 2 years? Yes [ ]; No [ ].

Thank you for your cooperation and time.

Appendix B: Result Tables

**Table B2**

*Frequency Distribution of Demographic Characteristics of Study Participants*

| Variable | Frequency (N=336) | Percent |
|---|---|---|
| LGA | | |
| Etsako West | 63 | 18.8 |
| Etsako Central | 55 | 16.4 |
| Esan West | 70 | 20.8 |
| Esan North East | 51 | 15.2 |
| Ovia North East | 43 | 12.8 |
| Uhunmwode | 54 | 16.1 |
| Age (Mean: 37.2 ±13.1 years) | | |
| 18-29 years | 110 | 32.7 |
| 30-39 years | 93 | 27.7 |
| 40-49 years | 70 | 20.8 |
| 50-59 years | 43 | 12.8 |
| 60 years or older | 20 | 6.0 |
| Gender | | |
| Male | 165 | 49.1 |
| Female | 171 | 50.9 |
| Marital status | | |
| Married | 212 | 63.1 |
| Single | 98 | 29.2 |
| Widowed | 17 | 5.1 |
| Divorced/separated | 9 | 2.7 |
| Residence | | |
| Rural | 257 | 76.5 |
| Urban | 79 | 23.5 |
| Ethnic group | | |
| Esan | 123 | 36.6 |
| Afemai | 119 | 35.4 |
| Edo | 52 | 15.5 |
| Others | 42 | 12.5 |

**Table B3**

*Frequency Distribution of Socioeconomic Characteristics of Study Participants*

| Variable | Frequency (N= 336) | Percent |
|---|---|---|
| Current employment status | | |
| Self-employed | 225 | 67.0 |
| Employed in private or public setting | 70 | 20.8 |
| Unemployed | 41 | 12.2 |
| Major occupation in the last two years | | |
| Business/trading | 96 | 28.6 |
| Civil/private worker | 66 | 19.6 |
| Farming | 63 | 18.8 |
| Artisan | 61 | 18.2 |
| Unemployed | 50 | 14.9 |
| Personal monthly income in NGN (Median: N28,259.0) | | |
| Less than N30,000 | 203 | 60.4 |
| N30,000-N59,999 | 57 | 17.0 |
| N60,000-N89,999 | 22 | 6.5 |
| N90,000 or more | 13 | 3.9 |
| No income | 41 | 12.2 |
| Personal monthly income in USD (Median: $39.0) | | |
| $0.00-$99.99 | 226 | 67.3 |
| $100.00-$199.99 | 58 | 17.3 |
| $200.00-$299.99 | 5 | 1.5 |
| ≥$300 | 6 | 1.8 |
| No income | 41 | 12.2 |
| Household income in NGN (Median: N25,000.0) | | |
| <N100,000 | 319 | 94.9 |
| ≥N100,000 | 17 | 5.1 |
| Household income in USD (Median: $65.0) | | |
| <USD100 | 227 | 67.6 |
| ≥USD100 | 109 | 32.4 |
| Highest level of education attained | | |
| No formal education | 30 | 8.9 |
| Primary | 70 | 20.8 |
| Secondary | 109 | 32.4 |
| Tertiary | 127 | 37.8 |
| Functional health facility in the community | | |
| Yes | 307 | 91.4 |
| No | 29 | 8.6 |
| Distance between respondent's house and nearest health facility | | |
| Less than or up to 5 km | 247 | 73.5 |
| More than 5 km | 54 | 16.1 |
| Not sure | 35 | 10.4 |

**Table B4**

*Housing Conditions of Respondents*

| Variable | Frequency (***N*** = 336) | Percent |
|---|---|---|
| Type of house | | |
| Mud/thatch house | 101 | 30.1 |
| Brick house | 235 | 69.9 |
| Presence of rodent entry points | | |
| Yes | 184 | 54.8 |
| No | 42 | 12.5 |
| Not sure | 110 | 32.7 |
| Number of rodent entry points | | |
| 1-4 | 136 | 40.5 |
| 5-9 | 34 | 10.1 |
| 10 or more | 14 | 4.2 |
| None or not sure | 152 | 45.2 |
| Presence of open waste bins or dump sites | | |
| Yes | 217 | 64.6 |
| No | 119 | 35.4 |
| Conditions of surroundings | | |
| Well kempt | 207 | 61.6 |
| Littered | 70 | 20.8 |
| Bushy | 59 | 17.6 |

**Table B5**

*Morbidity and Mortality of Lassa Fever in the Study Population*

| Variable | Frequency (N= 336) | Percent |
|---|---|---|
| Burden of Lassa fever in reporting wards* | | |
| Low | 186 | 55.4 |
| Medium | 43 | 12.8 |
| High | 107 | 31.8 |
| Diagnosed as a case of Lassa fever in the last 2 years | | |
| Yes | 59 | 17.6 |
| No | 277 | 82.4 |
| When diagnosed | | |
| Less than 6 months ago | 8 | 2.4 |
| 6 to 12 months ago | 14 | 4.2 |
| Over 12 months ago | 37 | 11.0 |
| Not a case | 277 | 82.4 |
| Are there other cases of Lassa fever in your house? | | |
| Yes | 24 | 7.1 |
| No | 276 | 82.1 |
| Not sure | 36 | 10.7 |
| Any death from Lassa fever in the last 2 years | | |
| Yes | 12 | 3.6 |
| No | 324 | 96.4 |

*Classified as: Low-- <10 cases; Medium—10-19 cases; High-- ≥20 cases.

**Table B6**

*Cross Tabulation of Age and Lassa Fever transmission*

| Age (in years) | Transmission of Lassa fever [(Count (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| 18-29 | 60 (54.5) | 17 (15.5) | 33 (30.00 | 110 (100.0) | $\chi^2$= 10.857 |
| 30-39 | 45 (48.4) | 12 (12.9) | 36 (38.7) | 93 (100.0) | *p*= 0.210 |
| 40-49 | 41 (58.6) | 4 (5.7) | 25 (35.7) | 70 (100.0) | |
| 50-59 | 26 (60.5) | 8 (18.6) | 9 (20.9) | 43 (100.0) | |
| ≥60 | 14 (70.0) | 2 (10.0) | 4 (20.0) | 20 (100.0) | |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B7**

*Cross Tabulation of Gender and Lassa Fever Transmission*

| Gender | Transmission of Lassa fever [Count (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| Male | 88 (53.3) | 22 (13.3) | 55 (33.3) | 165 (100.0) | $\chi^2$= 0.538 |
| Female | 98 (57.3) | 21 (12.3) | 52 (30.4) | 171 (100.0) | *p*= 0.764 |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B8**

*Cross Tabulation of Marital Status and Lassa Fever Transmission*

| Marital status | Lassa fever transmission [Count (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| Married | 117 (55.2) | 29 (13.7) | 66 (31.1) | 212 (100.0) | $\chi^2$= 10.950 |
| Divorced/separated | 9 (100.0) | 0 (0.0) | 0 (0.0) | 9 (100.0) | *p*= 0.090 |
| Widowed | 12 (70.6) | 1 (5.9) | 4 (23.5) | 17 (100.0) | |
| Single | 48 (49.0) | 13 (13.3) | 37 (37.8) | 98 (100.0) | |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B9**

*Cross Tabulation of Residence and Lassa Fever Transmission*

| Residence | Lassa fever transmission [Count (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| Rural | 170 (66.1) | 29 (11.3) | 58 (22.6) | 257 (100.0) | $\chi^2$= 54.490 |
| Urban | 16 (20.3) | 14 (17.7) | 49 (62.0) | 79 (100.0) | *p*<0.001 |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B10**

*Cross Tabulation of Household Size and Lassa Fever Transmission*

| Household size | Lassa fever transmission [Count (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| 1 person | 15 (65.2) | 2 (8.7) | 6 (26.1) | 23 (100.0) | $\chi^2$= 1.535 |
| 2-4 persons | 74 (54.4) | 16 (11.8) | 46 (33.8) | 136 (100.0) | *p*= 0.820 |
| More than 4 person | 97 (54.8) | 25 (14.1) | 55 (31.1) | 177 (100.0) | |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B11**

*Cross Tabulation of Ethnic Group and Lassa Fever Transmission*

| Ethnic group | Lassa fever transmission [Counts (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| Afemai | 80 (67.2) | 9 (7.6) | 30 (25.2) | 119 (100.0) | $\chi^2$= 66.648 |
| Edo | 41 (78.8) | 9 (17.3) | 2 (3.8) | 52 (100.0) | $p$<0.001 |
| Esan | 51 (41.5) | 10 (8.1) | 62 (50.4) | 123 (100.0) | |
| Others | 14 (33.3) | 15 (35.7) | 13 (31.0) | 42 (100.0) | |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B12**

*Model Fitting Information for Regression Model for Demographic Determinants of Lassa Fever Transmission*

| Model | Model Fitting Criteria | Likelihood Ratio Tests | | |
|---|---|---|---|---|
| | -2 Log Likelihood | Chi-Square | df | Sig. |
| Intercept Only | 502.062 | | | |
| Final | 413.608 | 88.454 | 8 | .000 |

**Table B13**

*Goodness-of-fit for Regression Model for Demographic Determinants of Lassa Fever Transmission*

| Parameter | Chi-Square | df | Sig. |
|---|---|---|---|
| Pearson | 343.248 | 322 | .199 |
| Deviance | 315.057 | 322 | .598 |

**Table B14**

*Multinomial Logistic Regression of Demographic Variables Influencing Lassa Fever Transmission*

| Determinants of Lassa fever transmission | B | Sig. | Exp. (B) | 95% CI for Exp. (B) | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| Low transmission | | | | | |
| Intercept | -.638 | .294 | | | |
| Age | .008 | .437 | 1.008 | .987 | 1.030 |
| Rural residence | 1.945 | .000 | 6.991 | 3.580 | 13.651 |
| Urban residence | 0 | . | . | . | . |
| Afemai ethnic group | -.436 | .254 | .647 | .306 | 1.367 |
| Esan ethnic group | -1.066 | .005 | .344 | .164 | .720 |
| Other ethnic groups | 0 | . | . | . | . |
| Medium transmission | | | | | |
| Intercept | 1.048 | .184 | | | |
| Age | -.018 | .259 | .982 | .952 | 1.013 |
| Rural residence | .208 | .626 | 1.231 | .534 | 2.841 |
| Urban residence | 0 | . | . | . | . |
| Afemai ethnic group | -1.794 | .000 | .166 | .061 | .455 |
| Esan ethnic group | -2.360 | .000 | .094 | .035 | .252 |
| Other ethnic groups | 0 | . | . | . | . |

*Note.* The reference category is: High Lassa fever transmission. CI= Confidence interval

**Table B15**

*Cross Tabulation of Employment Status and Lassa Fever Transmission*

| Employment status | Lassa fever transmission [Counts (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| Self employed | 129 (57.3) | 30 (13.3) | 66 (29.3) | 225 (100.0) | $\chi^2$= 1.997 |
| Employed under private or public authority | 36 (51.4) | 8 (11.4) | 26 (37.1) | 70 (100.0) | *p*= 0.736 |
| Unemployed | 21 (51.2) | 5 (12.2) | 15 (36.6) | 41 (100.0) | |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B16**

*Cross Tabulation of Occupation and Lassa Fever Transmission*

| Major occupation in the last two years | Lassa fever transmission [Count (%)] Low | Medium | High | Total | Statistics |
|---|---|---|---|---|---|
| Artisan | 39 (63.9) | 10 (16.4) | 12 (19.7) | 61 (100.0) | $\chi^2$= 46.390 |
| Business/trading | 38 (39.6) | 16 (16.7) | 42 (43.8) | 96 (100.0) | $p$<0.001 |
| Civil servant/private worker | 30 (45.5) | 5 (7.6) | 31 (47.0) | 66 (100.0) | |
| Farming | 54 (85.7) | 5 (7.9) | 4 (6.3) | 63 (100.0) | |
| Unemployed | 25 (50.0) | 7 (14.0) | 18 (36.0) | 50 (100.0) | |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B17**

*Cross Tabulation of Educational Attainment and Lassa Fever Transmission*

| Educational attainment | Lassa fever transmission [Counts (%)] Low | Medium | High | Total | Statistics |
|---|---|---|---|---|---|
| No formal education | 18 (60.0) | 5 (16.7) | 7 (23.3) | 30 (100.0) | $\chi^2$= 9.426 |
| Primary | 39 (55.7) | 14 (20.0) | 17 (24.3) | 70 (100.0) | $p$= 0.151 |
| Secondary | 65 (59.6) | 10 (9.2) | 34 (31.2) | 109 (100.0) | |
| Tertiary | 64 (50.4) | 14 (11.0) | 49 (38.6) | 127 (100.0) | |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B18**

*Cross Tabulation of Monthly Personal Income and Lassa Fever Transmission*

| Monthly personal income (USD) | Lassa fever transmission [Counts (%)] Low | Medium | High | Total | Statistics |
|---|---|---|---|---|---|
| <100 | 130 (57.5) | 32 (14.2) | 64 (28.3) | 226 (100.0) | Fisher's= 9.312 |
| 100-199 | 28 (48.3) | 4 (6.9) | 26 (44.8) | 58 (100.0) | $p$= 0.107 |
| 200-299 | 4 (80.0) | 1 (20.0) | 0 (0.0) | 5 (100.0) | |
| ≥300 | 3 (50.0) | 1 (16.7) | 2 (33.3) | 6 (100.0) | |
| Total | 165 (55.9) | 38 (12.9) | 92 (31.2) | 295 (100.0) | |

**Table B19**

*Cross Tabulation of Monthly Household Income and Lassa Fever Transmission*

| Monthly household income (USD) | Lassa fever transmission [Counts (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| <100 | 135 (59.5) | 30 (13.2) | 62 (27.3) | 227 (100.0) | $\chi^2$= 6.749 |
| ≥100 | 51 (46.8) | 13 (11.9) | 45 (41.3) | 109 (100.0) | *p*= 0.034 |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B20**

*Cross Tabulation of Availability of Health Facility and Lassa Fever Transmission*

| Availability of health facility in community | Lassa fever transmission [Counts (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| Yes | 168 (54.7) | 43 (14.0) | 96 (31.3) | 307 (100.0) | $\chi^2$= 4.689 |
| No | 18 (62.1) | 0 (0.0) | 11 (37.9) | 29 (100.0) | *p*= 0.096 |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B21**

*Cross Tabulation of Housing Condition and Lassa Fever Transmission*

| Housing condition | Lassa fever transmission [Counts (%)] | | | Total | Statistics |
|---|---|---|---|---|---|
| | Low | Medium | High | | |
| Poor | 108 (46.6) | 32 (13.8) | 92 (39.7) | 232 (100.0) | $\chi^2$= 25.435 |
| Good | 78 (75.0) | 11 (10.6) | 15 (14.4) | 104 (100.0) | *p*<0.001 |
| Total | 186 (55.4) | 43 (12.8) | 107 (31.8) | 336 (100.0) | |

**Table B22**

*Model Fitting Information for Regression Model for Socioeconomic Determinants of Lassa Fever Transmission*

| Model | Model Fitting Criteria | Likelihood Ratio Tests | | |
|---|---|---|---|---|
| | -2 Log Likelihood | Chi-Square | df | Sig. |
| Intercept Only | 593.433 | | | |
| Final | 531.646 | 61.787 | 12 | .000 |

**Table B23**

*Goodness-of-fit for Regression Model for Socioeconomic Determinants of Lassa Fever Transmission*

| Parameter | Chi-Square | df | Sig. |
|---|---|---|---|
| Pearson | 563.488 | 530 | .152 |
| Deviance | 496.918 | 530 | .846 |

**Table B24**

*Multinomial Logistic Regression of Socioeconomic Factors Affecting Lassa Fever Transmission*

| Determinants of Lassa fever transmission | B | Sig. | Exp. (B) | 95% CI for Exp. (B) Lower Bound | Upper Bound |
|---|---|---|---|---|---|
| Low transmission | | | | | |
| Intercept | 2.387 | .000 | | | |
| Personal income | .001 | .519 | 1.001 | .998 | 1.004 |
| Household income | -.001 | .568 | .999 | .996 | 1.002 |
| Formal occupation | -.949 | .008 | .387 | .192 | .782 |
| Non-formal occupation | 0 | . | . | . | . |
| At least secondary education | -.413 | .173 | .661 | .365 | 1.199 |
| Less than secondary education | 0 | . | . | . | . |
| Functional health facility | -.074 | .862 | .928 | .402 | 2.144 |
| No functional health facility | 0 | . | . | . | . |
| Poor housing condition | -1.686 | .000 | .185 | .096 | .356 |
| Good housing condition | 0 | . | . | . | . |
| Medium transmission | | | | | |
| Intercept | -16.679 | .000 | | | |
| Personal income | .000 | .862 | 1.000 | .995 | 1.004 |
| Household income | .003 | .116 | 1.003 | .999 | 1.006 |
| Formal occupation | -1.527 | .018 | .217 | .061 | .770 |
| Non-formal occupation | 0[b] | . | . | . | . |
| At least secondary education | -.835 | .040 | .434 | .196 | .963 |
| Less than secondary education | 0 | . | . | . | . |
| Functional health facility | 17.252 | . | 31067284.073 | 31067284.073 | 31067284.073 |
| No functional health facility | 0[b] | . | . | . | . |
| Poor housing condition | -.987 | .036 | .373 | .149 | .935 |
| Good housing condition | 0 | . | . | . | . |

*Note.* The reference category is: High Lassa fever transmission. CI= confidence interval

**Table B25**

*Cross Tabulation of Residence and Deaths from Lassa Fever*

| Residence | Lassa deaths | | Total | Statistics |
|---|---|---|---|---|
| | Low (<10.0%) | High (>/=10.0%) | | |
| Rural | 60 (23.3) | 197 (76.7) | 257 (100.0) | $\chi^2$= 76.094 |
| Urban | 61 (77.2) | 18 (22.8) | 79 (100.0) | $p$<0.001 |
| Total | 121 (36.0) | 215 (64.0) | 336 9100.0) | |