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Risk Factors Associated with the Contraction of Ebola Virus Disease in Liberia

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College of Health Sciences

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Beyan Y. Sana

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Walden University
2019

Abstract

Risk Factors Associated with the Contraction of Ebola Virus Disease in Liberia

by

Beyan Y. Sana

MPH, Walden University, 2016

BS, University of Maryland School of Medicine, 2008

BS, University of Liberia, 2001

Doctoral Study Proposal Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

Walden University

May 2019

Abstract

Ebola virus disease (EVD) is a highly transmittable disease with high mortality rate. The purpose of this study was to examine risk factors associated with the contraction of EVD in Liberia. A retrospective cross-sectional design was used to analyze secondary data collected on 1,658 patients admitted to Ebola treatment units in Liberia, using the social ecological model as a theoretical framework. Descriptive statistics and the chi-square test for association and logistic regression were used to analyze the data. The findings of this study revealed that funeral attendance, exposure to body fluids, and contact with a living sick person were associated with the contraction of EVD ($p < 0.05$). The likelihood of contracting EVD is 14.32 times greater among patients exposed to body fluids. The likelihood of contracting EVD is 15.34 times greater among patients exposed to a living sick person. The results failed to identify other factors such as gender, age, and community of residence as factors associated with the contraction of EVD. The findings of this study may foster social change through comprehensive EVD prevention and control programs by focusing on improving the quality of life of underprivileged communities, investing in social, educational, and community-based development programs such as roads, schools, sanitation, and health care facilities. Educational and community-based initiatives can encourage health and wellness by educating communities about the dangers EVD poses to their lives and well-being.

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Dedication

This capstone study is dedicated to my loving children (Joshua, Beyanna, and LeYan Sana); my wife, Roseline; my loving mother, Mrs. Desiree K. Zain; my father, Mr. John S. Sana; my uncle, Mr. G.S. Keamu; my family in Liberia; people that were affected by Ebola virus disease, both survival and deceased; and my entire family and friends around the world.

Acknowledgments

I would like to express my sincere thanks and appreciation to my Lord and Savior Jesus Christ for granting the strength to accomplish my dream.

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Table of Contents

List of Tables

List of Figures

Section 1: Foundation of the Study and Literature Review Search Strategy

Introduction

Ebola virus disease (EVD), named after the Ebola River in the Democratic Republic of Congo in the central region of Africa, is known to be a highly transmittable disease with a high mortality rate (Dietz, Jambai, Paweska, Yoti, & Ksiazek, 2015). Since the mid-1970s, EVD has posed a severe global health threat to many African nations. EVD was first detected in the Democratic Republic of Congo in 1976, but over 20 additional outbreaks of the virus have occurred in the western and central regions of Africa resulting in more than 28,000 cases of EVD (Dietz et al., 2015). EVD is caused by viruses in the family *Filoviridae* and genus *Ebolavirus* (Dietz et al., 2015).

EVD in humans often causes severe infection and begins with various symptoms such as high degree of fever, diarrhea, hemorrhage, sepsis, organ failure, vomiting, muscular pain, abdominal pain, and more (Furuse et al., 2017). Human-to-human contraction of the disease often occurs through close contact with body fluids, watery stools of a symptomatic person infected with the virus, or skin of EVD patients who have died of the virus (Centers for Disease Control and Prevention [CDC], 2017a). The outbreak of EVD in West Africa was the largest in history with a sustained transmission in several West African countries including Liberia, Guinea, and Sierra Leone (Khan, Naveed, Dur-e -Ahmad, & Imran, 2015). The EVD outbreak has been one of the most challenging global health emergencies in recent years, resulting in more than 19,000 confirmed and probable cases primarily in Liberia, Guinea, and Sierra Leone (Agua-Agum et al., 2016).

The outbreak of EVD in Liberia started in March 2014, which drew widespread attention to EVD as a threat to global health (Nyenswah et al., 2016). Liberia is in the western region of Africa—bordered by Guinea, Sierra Leone, and Ivory Coast (World Health Organization [WHO], 2017). In Liberia, more than 1.5 million of the population live in communities with extreme poverty, and the rate of adult literacy of under 43% (Fallah, Skrip, Gertler, Yamin, & Galvani, 2015). According to Fallah et al. (2015), over 70% of the urban population lives a community of slums characterized by the lack of sanitation, overcrowding, and increased crime rates.

The aim of my study was to determine whether there is an association between the contraction of EVD and a patient's gender, age, county of residence, contact with a living sick person, contact with dead bodies, funeral attendance, and exposure to body fluids by focusing on the relationship between the contraction of EVD and the potential risk factors. The findings of this study will contribute to positive social change by educating the people Liberia and other developing nations how to identify risk factors for EVD, thus preventing and controlling the spread of EVD. This study will also contribute to positive social change by informing future efforts to improve EVD outbreak reviews at the individual level and community level and to implement health programs that will reduce the rate of EVD contraction, transmission, and deaths in Liberia. The recent outbreak of the disease in the Democratic Republic of Congo (WHO, 2018a) makes it urgent to mount sustained efforts to continue the fight against the spread of EVD.

The complex and unprecedented EVD outbreak in Liberia has highlighted the need to study and understand the risk factors associated with contraction of EVD as well as understanding public health intervention against EVD contraction. The current outbreak in the Democratic Republic of the Congo also highlights the need to examine factors associated with EVD (WHO, 2019). Recently, the Ministry of Health of the Democratic Republic of Congo and the WHO reported the outbreak of EVD. On May 21, 2018, a total of 58 EVD cases, including 27 deaths, were reported from three healthcare provinces in the Democratic Republic of the Congo (WHO, 2018b). Since May 28, 2018, over 992 registered contacts with suspected case-patients have been traced (WHO, 2018b). Although understanding public health interventions for improving and preventing the contraction and spread of EVD remains a critical requirement to accomplishing a complete eradication of the disease, knowing and understanding factors that are associated with the contraction of the disease is critical, which validated the need for this research study.

The study is needed because it will contribute to the body of knowledge of public health initiatives by investigating potential risk factors that are linked to the contraction of EVD, which will help to reduce and control future EVD outbreaks, as well as other infectious diseases in Liberia. Using public health education and public health awareness will help minimize and control the spread of future outbreaks. Also, community-based intervention strategies such as modification in traditional burial practices; motivating families and communities to help health workers in contact tracing to counter the rising trend of the virus by encouraging active participation by families and communities; and empowering individuals, families, and communities about the key risk factors for contracting EVD will reduce and control the spread of EVD. My findings on the risk factors associated with the contraction of EVD may contribute to the efforts for educating the people Liberia and other developing nations and preventing and controlling the spread of EVD. This doctoral study will help by providing an epidemiological basis for how the association of known and unknown factors can guide decision-making about reducing and controlling EVD in Liberia. The information provided from this study will help the ongoing plans by decision-makers in Liberia to use available research evidence to manage and control the spread of EVD infection in order to ensure good EVD outcomes.

The findings of this study will help buttress future investigations and may lead to a deeper understanding about the contraction of EVD in Liberia. The results of this study will be used to create public health interventions to raise awareness about the disease so that people will understand how the virus is transmitted. Understanding the factors that contribute to EVD is paramount in any EVD prevention and control initiatives. Identifying the risk factors of EVD contraction could help guide public health interventions and target public health resources during an outbreak of EVD. Social change can be realized when a comprehensive EVD control and elimination strategies are adopted that protect and save lives in and around Liberia and other EVD affected nations.

In this section of this capstone study, I examined and evaluated secondary data on EVD cases from Ebola treatment units reported from October 2014, to May 2015, in order to determine the risk factors associated with the outbreak of EVD in Liberia. The dataset includes independent variables such as patients' age, gender, county of residence, funeral attendance, contact with a living sick person, and the exposure to body fluids, and a dependent variable, the contraction of EVD. In this section, I also elucidate the problem statement, the purpose of the study, the research questions and hypotheses, the nature of the study, and the study's significance, and I provide a brief discussion of the theoretical framework on which this study is grounded. I define key terms used in the study and discuss the literature review strategy related to the key variables used in the study.

Problem Statement

According to WHO (2018b), there is an active and ongoing Ebola outbreak in the Democratic Republic of Congo. However, the 2014 outbreak of EVD in West Africa was the largest outbreak in history with a sustained spread in multiple West African nations including Liberia (Dietz et al., 2015). The outbreak of EVD in the West African nations of Liberia, Guinea, Sierra Leone, and Nigeria recorded more than 4,500 cases and 2,200 probable and confirmed EVD cases and deaths by the end of September 2014 (Mohammed et al., 2015). In 2014, the rapid spread of EVD resulted in the loss of thousands of lives among the people of Liberia (Li et al., 2016). The outbreak of the disease was marked by intense, wide spreading in communities, villages, and regions in and around Liberia (Furuse et al., 2017). EVD causes an acute illness with an average case fatality rate that varies from 25% to 90% during outbreaks (WHO, 2017). According to Coltart, Lindsey, Ghinai, Johnson, and Heymann (2017), EVD causes serious hemorrhagic fever in human beings with significant outbreak probability and high case fatality rates. In 2014, the outbreak of EVD in West Africa affected more than 28,000 people and caused over 11,000 deaths with the average case mortality rate of about 50% (WHO, 2017). The 2014 outbreak of EVD in Liberia, Guinea, and Sierra Leone was the largest ever recorded outbreak in West Africa (Dietz et al., 2015). EVD is characterized by the sudden onset of malaise and fever, headache, vomiting, diarrhea, abdominal pain, and other symptoms (Dietz et al., 2015). Cultural beliefs and practices that include touching dead bodies at funerals and washing dead bodies before burial played a significant role in the transmission of EVD (Stanturf, Goodrick, Warren, Charnley, & Stegall, 2015).

The severity of the disease leads to multiorgan failure and death, with an overall fatality rate of 50-90% (Dietz et al., 2015). The 2014 outbreak of EVD shut down most healthcare facilities, hampering diagnosis and treatment for infectious diseases and disrupting public health programs for preventing and treating malaria, typhoid fever, lesser fever, tuberculosis, HIV/AIDS, vaccine-preventable diseases, and other communicable diseases (Parpia, Ndeffo-Mbah, Wenzel, & Galvani, 2016). Before the WHO declared Liberia to be Ebola-free, the nation suffered about 10,604 cases and 4,769 deaths (Stanturf et al., 2015). Liberia was one of the countries in West Africa that was affected the most by the outbreak (Furuse et al., 2017).

The outbreak was fast-moving, creating challenges for many international organizations, public health programs, and healthcare professionals. The quantities and qualities of leaders, human resources, logistic support, and supplies, including personal protective equipment, could not keep up with the outbreak (WHO, 2016). The weak health systems, deep-rooted traditional burial behaviors, high level of mobility, and early spread of disease in the rural and urban areas contributed significantly to the unprecedented level of the outbreak in Liberia. The magnitude of the epidemic in Liberia was underestimated because many family members hid infected loved ones in their homes. Also, some families believed that infected loved ones would be more at ease dying at home than at the Ebola treatment units, and some feared the stigma and social rejection that come to families and patients when the diagnosis of the disease is confirmed (WHO, 2017). In the rural and urban settings, bodies were buried without notifying health care officials and without investigation of the cause of death (WHO, 2016).

In this cross-sectional retrospective research study, I investigated the potential risk factors associated with the contraction of EVD. Even though the CDC and the WHO emphasized the significance of contact tracing, safe and dignified burials, and community awareness as the most effective method for preventing and containing EVD cases, failure to educate people about the outbreak continued to increase the incidence rate (Dixon et al., 2015). To quantify the risk factors for the contraction of EVD, I performed descriptive analyses, analyzing secondary data collected by the Liberia Ministry of Health during the outbreak in Liberia. Although several research studies have examined risk factors for the transmission of EVD, very few research studies have been performed to examine multiple risk factors associated with the contraction of EVD, especially in Liberia. Risk factors such as age groups, gender (male and female), county of residence, funeral attendance, and contact with body fluids have not been fully identified in research studies as the possible cause of the spread and contraction of EVD in Liberia. I analyzed and conducted a study looking at different age groups and EVD in Liberia. In Sierra Leone, one of the countries affected by the outbreak of EVD in West Africa, people of younger age groups suffered an increased case fatality rate during the 2014 outbreaks of EVD (Bangura et al., 2016).

This doctoral study contributed to the body of knowledge by examining and investigating multiple risk factors that are related to the contraction of EVD, which will help in reducing and controlling future EVD and other infectious diseases outbreaks in Liberia using public health education, public health awareness, community-based intervention strategies such as modification in traditional burial practices, and motivating families and communities to help health workers in contact tracing to counter the rising trend of virus contraction. My findings on the risk factors associated with the contraction of EVD may contribute to the efforts for educating the people Liberia and other developing nations and preventing and controlling the spread of EVD.

Purpose of the Study

The purpose of this capstone research study was to investigate the risk factors associated with the contraction and spread of EVD. I investigated how these risk factors differed according to county of residence, age, gender, funeral attendance, exposure or contact with body fluids, and contact with suspected cases or ill individuals by analyzing data from the 2014 outbreak of EVD in Liberia in a sample of patients admitted at various Ebola treatment centers in Liberia. The contraction of EVD is the dependent or outcome variable, and variables such as the age of the patients, gender of the patients, contact with a suspected case or ill person, funeral attendance, contact with body fluids, and county of residence served as the independent variables. Although several studies in Guinea, the Democratic Republic of Congo, Liberia, and Sierra Leone have studied the transmission of EVD, no researchers have investigated how EVD can be contracted. Based on the secondary data obtained from the National Public Health Institute of Liberia (NPHIL), the contraction of EVD (dependent variable) refers to patients that were either tested or confirmed positive or negative for EVD by reverse transcriptase-polymerase chain reaction (RT-PCR).

Based on the secondary data, the risk factor of age group (independent variable) refers to the years of life at the time the patients' history and laboratory testing were obtained and stored in the database. According to Chérif et al. (2017), people under the age of 20 years were affected by EVD in Guinea. During the 2014 outbreak of EVD, a nationwide retrospective cohort study was conducted in Guinea among children under 20 years of age that found that among 8,448 children with suspected or probable case of EVD, 695 were highly susceptible to death (Chérif et al., 2017). Children less than five years of age had the highest case fatality rate of 82.9%, with common clinical features of high fever, fatigue, weakness, and diarrhea (Chérif et al., 2017). It is important to note that the outbreak of EVD started December 2013, in Guinea, where the first case of the disease was reported in a 2-year-old child that resulted in death (Chérif et al., 2017). Preventing the exposure of children in EVD-affected homes may be difficult because children need to be fed, held, played with, and cared for (Bower et al., 2016). During the outbreak of EVD, it was suggested that young children were vulnerable and highly susceptible to contracting EVD (Chérif et al., 2017). Due to the difference in time during the outbreak in West Africa, there might be a difference in age groups and gender among people who were affected in Liberia than in Guinea. I used secondary data from the NPHIL to or correlate the difference in age groups and the contraction of EVD.

In this doctoral study, I examined gender as one of the possible factors associated with the outbreak of EVD in Liberia. The differences in gender (male and female) described how male and female can influence the pattern of exposure to EVD. A research study by Bower et al. (2016) conducted in Serra Leone indicates that the exposure patterns are most likely to differ by gender (female and male). According to Bower et al. (2016), females may be more at risk of contracting EVD from caring for those who are sick at home and males from transporting people that are sick to healthcare facilities.

In this study, I used the secondary data to examine the association between epidemiological risk factors such as the history of funeral rites or attendance, contact with body fluids, and contact with a suspected case person and the contraction of EVD. The history of attending funerals is known to be a risk factor associated with the contraction and transmission of EVD (Agua-Agum et al., 2016). Safe funeral practices can influence or contribute to the containment of the outbreak of EVD (Agua-Agum et al., 2016). In One of the most important funeral rituals common among the people of Liberia was the washing of dead bodies with their bare hands and spending time with the corpse before burial (Coltart et al., 2017). In Sierra Leone, funeral rituals or practices varied with differences between the Christians and Muslim practices—Muslims will wash the corpse and bury the same day, whereas Christians will wait for up to several weeks to make funeral arrangement for their loved ones to be buried (Nielsen et al., 2015). Funerals are important occasions where people value attendance and travel long distances to attend (Nielsen et al., 2015).

The exposure to body fluids such as urine, blood, vomit, and more has been known as a potential risk factor for the transmission of EVD (Deen et al., 2017). According to Olu et al. (2016), persons exposed to body fluids and people who had multiple contacts with body fluids were vulnerable to contracting EVD. Knowing how and from whom people acquired the disease can assist in providing information in responding to the disease by limiting the impact of the outbreak (Agua-Agum et al., 2016).

Research Questions and Hypotheses

I used the following research questions in this quantitative study to investigate the risk factors associated with the 2014 outbreak of EVD in Liberia:

RQ1: What is the relationship between the contraction of EVD and individuals' age group and gender?

$H_0$1a: There is no association between individuals' age group and the contraction of EVD.

H_A1a: There is a statistically significant association between individuals' age group and the contraction of EVD.

$H_0$1b: There is no association between individuals' gender and the contraction of EVD.

H_A1b: There is a statistically significant association between individuals' gender and the contraction of EVD.

RQ2: What is the relationship between individuals' counties of residence and the contraction of EVD?

$H_0$2: There is no association between individuals' counties of residence and the contraction of EVD.

H_A2: There is an association between individuals' counties of residence and the contraction of EVD.

RQ3: What is the relationship between funeral attendance and the contraction of EVD?

$H_0$3: There is no association between funeral attendance and the contraction of EVD.

H_A3: There is an association between funeral attendance and the contraction of EVD

RQ4: What is the relationship between exposure to body fluids and contact with a living sick person and contraction of EVD?

$H_0$4a: There is no association between the exposure to body fluids and the contraction of EVD.

H_A4a: There is an association between the exposure to body fluid and the contraction of EVD.

$H_0$4b: There is no association between the contact with a living sick person and the contraction of EVD.

H_A4b: There is an association between the contact with a living sick person and the contraction of EVD.

Theoretical Foundation for the Study

The theoretical foundation or framework that supported this study was the social ecological model (SEM). The SEM was first employed by Bronfenbrenner (1979) and later modified by Baral, Logie, Grosso, Wirtz, and Beyrer (2013) and the CDC (2015a) for cancer screening initiatives and the assessment of HIV risk factors. Although the SEM framework has been applied to cancer screening, influenza vaccine uptake, and HIV screening, the model can also be applied to other factors associated with infectious diseases (Baral et al., 2013). The SEM provided the theoretical framework for this multilevel cross-sectional study that utilized secondary data on EVD from the Ministry of Health in Liberia. The SEM is a theoretical model with numerous bands of influence (CDC, 2015a). The SEM provided information at the individual, interpersonal, community, and policy levels as to how and when individuals can recognize the risk factors such as contact with a living sick person, touching dead bodies at funerals, and washing dead bodies before burial associated with the contraction of EVD. The SEM allows a researcher to address factors that put people at risk for contracting Ebola and prevention strategies that can be used at the individual, interpersonal, organizational, community, and environmental levels.

McLeroy, Bibeau, Steckler, and Glanz (1988) discuss that individual behavior is shaped by factors at multilevel including individual, interpersonal, community, organizational, and environmental or policy levels. The SEM can be adapted to contextualize or understand the risk of EVD contraction among people who are vulnerable to the disease (Baral et al., 2013). SEM can be utilized to investigate the risk factors associated EVD at the (a) individual level, identifying factors such as age and gender; (b) interpersonal level, examining close relationships and contacts and the exposure to body fluids which may increase the risk of EVD; (c) community level, examining communities and counties of residence; and (d) environmental or policy level, clarifying funeral or burial rituals. The SEM makes available a framework to determine how to focus intervention programs to prevent the spread, transmission, and contraction of the disease (CDC, 2015a). It is paramount to implement intervention programs and policies that can minimize the risks factors associated with EVD at each level of the SEM (CDC, 2015a).

At the individual level, the SEM has been utilized in the design of effective interventions targeted at modifying individuals' behaviors (Baral et al., 2013). Individual factors are biological factors that increase the vulnerability of becoming infected with the virus (Baral et al., 2013). Prevention strategies at the individual level are frequently designed to promote behaviors and beliefs that in the end prevent the contraction of the disease (CDC, 2015a). Also, the SEM provides a foundation for looking into influences of multiple social elements and defining the need for public health and health care professionals to act across multiple levels of the model to maximize the combined effect of initiatives for the most significant impact (CDC, 2015a).

Nature of the Study

The nature of this doctoral study involves a quantitative approach consistent with examining and understanding the association between an independent and dependent variable. I used a secondary data collected by public health and health care professionals during and after the outbreak of EVD in Liberia in 2014 to investigate the factors associated with the contraction of EVD during the outbreak among patients who were examined at various Ebola treatment units in Liberia. In collaboration with the Ministry of Health of Liberia, NPHIL collected data in more than 12 counties and over 200 communities in and around Liberia (NPHIL, 2017). NPHIL is working with other international organizations including the CDC, National Institute of Health (NIH), WHO, and more to strengthen existing infection prevention and control efforts, surveillance laboratories, infectious disease control, public health capacity building, and monitoring and rapid response to outbreaks of infectious diseases (NPHIL, 2017).

In this cross-sectional study, I examined the association between the disease or health-related characteristic (contraction of EVD) and other variables of interest that I established (see Aschengrau & Seage, 2014). A cross-sectional retrospective study design was appropriate for this study because it examines association at a single point in time (Aschengrau & Seage, 2014) and thus could measure contact or exposure prevalence in connection to the disease prevalence. I examined several risk factors such as (a) physical contact with a person ill with EVD or contact with dead bodies, (b) contact with someone after death, (c) contact with a living sick person, (d) age, € gender, and (f) individuals' counties of residence to determine the burden posed by the disease on the people of Liberia. I employed or used logistic regression analysis and Chi-square test of association to determine the effect of my independent variables of sex or gender, age groups, county of residence, close contact with a living sick person, touching dead bodies, and washing dead bodies before burial on my dependent variable of contraction of EVD.

Literature Search Strategy

I conducted a literature search for this capstone study by searching numerous databases and credible government online sites including the Walden University Library Database, the Johns Hopkins University and Hospital Databases, CDC Emerging Infectious Disease Journal, the WHO website, Google Scholar, and the Liberia Ministry of Health databases and search engines. Peer-reviewed journal articles for this study were from the Walden University Library databases by accessing the Health Sciences Research Databases.

The search from the Walden University Health Sciences Databases included the MEDLINE with full text; the CINAHL Plus with full-text; the ProQuest Nursing and Allied Health Source; PubMed; and Science Direct. The MEDLINE with full text database provides medical information on infectious diseases, medicine, clinical sciences, health care system, and more with full-text content (Walden University Library, 2018). The CINAHL Plus with full-text database contains research journals, e-books on a wide range of allied health topics with peer-reviewed research articles, case studies, systematic reviews, and reports of evidence-based practice (Walden University Library, 2018). The ProQuest Nursing and Allied Health Source database provide users with trustworthy and reliable health information covering infectious and chronic illnesses, allied health, nursing information, complementary and alternative medicine, and more (Walden University Library, 2018).

The PubMed database consists of over 20 million citations for life science journals, biomedical literature, and e-books that are developed and maintained by the

National Center for Biotechnology Information at the National Library of Medicine. The Science Direct database contains full-text journals with content in research sciences including nursing, allied health, and medicine (Walden University Library, 2018). The Johns Hopkins Welch Medical Library was used to search for peer-reviewed journal articles carry out the literature review for this study. The Johns Hopkins Welch Medical Library serves hospital staff, faculty, and students of the Johns Hopkins Medical Institutions. A literature search from the Welch Medical Library database includes popular resources, e-books, and e-journals like the *JAMA*, *Lancet*, *The New England Journal of Medicine*, and more (Welch Medical Library, 2018).

I used the following keywords to search credible universities and online government databases in this literature review: *Ebola virus disease, Ebola virus disease outbreak in Liberia, Ebola virus disease contraction; risk factors associated with Ebola virus Disease; Ebola and its control in Liberia; community and county spread of Ebola, age and gender-related Ebola virus disease, social ecological model,* and *Ebola treatment units.* The keywords were searched collectively and individually.

The literature review resources selected for review for this study were based on an inclusion and exclusion criteria. Literature sources that were included in the review were published from 2013 to 2018, except for few articles pertinent to this capstone study. The source of the literature was found to be related and relevant to the research questions and hypotheses. Peer-review journal articles that were written or published more than 5 years ago were excluded from the search, except for few research articles from credible sources that were relevant to this research study. The sources of the literature were peer-reviewed or provided by university databases and credible government online sites. Research studies that evaluated differences in EVD contraction by individual factors included age and gender; interpersonal factors including close contact or close relationship with living sick persons and exposure to body fluid; and community factors including county and community residence. Peer-reviewed journal articles that were published in a language other than English were excluded from the literature review.

Literature Review Related to Key Variables and/or Concepts

In this section, I examined literature on key variables of this study including the geographical location and population of Liberia, the epidemiology of the outbreak of EVD in Liberia, risk factors associated with the contraction of EVD including age, gender, community and county of residence, funeral attendance of the dead, exposure to body fluids; and close contact with the living sick persons. I describe the gaps in the literature that are related to the risk factors associated with the contraction of EVD.

Population and Geographical Location of Liberia

This doctoral study primarily focusses on Liberia, where the 2014–2015 outbreaks of EVD were more prevalent (see Figure 1 below). Liberia is a relatively dense nation located on the west coast of Africa, bordered by Guinea, Ivory Coast, and Sierra Leone (WHO, 2016). Liberia is one of the smallest and lowest-income nations in Africa with a population of more than 4.6 million people (WHO, 2016). The birth rate of Liberia is 38.3 births per 1,000 population. The death rate of Liberia is 7.6 deaths per 1,000 population (WHO, 2016). According to the WHO (2016), more than half of the population in Liberia lives in the urban areas, with one-third of the total population living within 40 to 50 miles of Monrovia, the capital city of Liberia. Liberia is a low-income nation that went through 14 years of civil wars with significant impact on the healthcare system, the disease surveillance system, and the health workforce, which have contributed to the lack of achievement of the Millennium Development Goals (Keys, Midturi, & Chambers-Kersch, 2015). Liberia has one of the highest rates of infectious diseases transmission and contraction including vector-borne diseases (malaria, yellow fever, and dengue fever); food or waterborne diseases (typhoid fever, diarrhea disease, hepatitis A, and schistosomiasis); soil or aerosolized dust contact disease (Lassa fever); and animal contact disease (rabies WHO, 2016).

Figure 1. Map of Liberia showing the counties of Liberia. Retrieved from https://wwwnc.cdc.gov/travel/destinations/clinician/none/liberia

Epidemiology of Ebola Virus Disease in Liberia

EVD is an infectious disease that causes severe infection in human, causing several symptoms that include diarrhea, fever, hemorrhage, vomiting, muscle pain, skin rash, and more (Olu et al., 2015). EVD is one of the most severe infectious diseases that is known to have a high case-fatality rate of 40-90% (Li et al., 2016). EVD is contracted and transmitted from human-to-human through close contact with infected individuals, contact with contaminated environments, contact with body fluids or contact with a dead body of an effected EVD patient (Olu et al., 2015). The incubation periods of the virus to onset of symptoms take 2 to 21 days to manifest on the human body (WHO, 2017). EVD belongs to the virus family *Filoviridae* and genus *Ebolavirus*. The Ebola virus that caused the 2014 EVD outbreak in Liberia belongs to the Zaire ebolavirus species (Lindblade et al., 2015).

In 2014, Liberia experienced a major outbreak of EVD resulting in over 10,600 cases and 4,800 deaths (Nyenswah et al., 2016). The epidemic of EVD in Liberia drew widespread attention to EVD as a threat to global public health security (Nyenswah et al., 2016). At the onset of the outbreak, there was little information known about the epidemiology, risk factors, and mode of contraction in urban areas (Nyenswah et al., 2016). The 2014 EVD outbreak was the largest and most complex EVD outbreak recorded since the disease was first detected and discovered in 1976 (WHO, 2017). By March 2016, the outbreak of EVD had affected more than 28,000 people, resulting in more than 11,200 deaths in nine countries including Liberia (Furuse et al., 2017).

Liberia was among one of the low-income nations in Africa that was hit the hardest during the outbreak with over 10,600 suspected, probable, and confirmed cases—resulting in more than 4,800 deaths Liberia (Furuse et al., 2017). During the outbreak, people that were sick in their communities were interviewed by a team of trained public health professionals and community health workers to investigate whether they were probable or suspected cases of EVD. According to Furuse et al. (2017), patients who visited hospitals and community clinics in Liberia were examined to see whether they were probable or suspected cases for the contraction of EVD. When patients were determined to be suspected cases of EVD, they were transported by the Ebola case investigation teams to the nearest Ebola Treatment Units (Furuse at al., 2017).

Gender and Ebola Virus Disease

In defining gender differences between male and female, the study by Nkangu, Olatunde, and Yaya (2017) described how the roles of gender could influence the pattern of exposure to infectious diseases. Furuse et al. (2017) conducted a retrospective research study to analyze patient data from laboratories during the EVD epidemic in West Africa. Furuse et al. (2017) analyzed patients' data from 10 laboratories that were operated by national and international agencies in Liberia. Furuse et al. (2017) noted that gender with other factors like age and place of EVD onsets showed significant differences between confirmed cases of EVD and suspected cases that tested negative for the RNA of EVD. The approach used by Furuse et al. (2017) to analyze patient data from laboratories was most suitable to investigate factors related to the fatality of EVD because it detected differences in the prevalence of demographic factors (gender, age, and place of residence) between confirmed cases and negative suspected cases of EVD. Furuse et al. (2017) noted that many of the cases reported in the data surveillance system had missing information on the potential exposure to the disease and a delay of 2-4 weeks in case reporting and laboratory analysis.

According to a study conducted by Nkangu et al. (2017), the differences among the 20,035 cases of EVD reported in Liberia, Guinea, and Sierra Leone during the 2014 EVD outbreak—males and females had a similar average rate of contracting EVD with the frequency of exposure higher among females than males. The incidence of EVD among women was 34.3%, 95% confidence interval (CI); and men were 30.7%, 95% CI with the $P<0.001$. From 1976 to 2012, over 1530 people died from previous EVD outbreaks in Africa compared with more than 11,300 deaths from the 2014 outbreak—females were affected the most due to their time spent at home and caring for the sick. During the EVD outbreaks, women were on the frontline as caregivers in homes, communities, and as healthcare workers providing care for sick (Fawole, Bamiselu, Adewuyi, & Nguku, 2016).

A study by Agua-Agum et al. (2016) indicated that the average interval from symptom onset for the contraction of EVD to hospitalization was about 12 hours shorter among female than male patients at $p <0.05$ (Agua-Agum et al., 2016). Agua-Agum et al. discovered that female patients were least likely to die from EVD than male patients with a case fatality rate, 63.0% for females and 67.1% for males; odds ratio of 0.83; 95% CI, 0.77 to 0.91. Agua-Agum et al. found significant differences in higher survival rate among female patients than male patients that were hospitalized at various Ebola

Treatment Units across the country. Male patients spent more time (12.5% longer) — about 12 hours on average in their respective communities while producing sign and symptom of EVD than female patients, making the risk of contraction and transmission in the last 12 hours higher than average (Agua-Agum et al., 2016). Dietz et al. (2015) explained that 51.7% of the people that contracted or confirmed positive for EVD were female. Gender or sex-specific differences can play a significant role in creating public health measures to reduce community-based spread of EVD (Agua-Agum et al., 2016). Li et al. (2015) found no significance difference between males and female (p = 0.119).

Age or Age Groups and Ebola Virus Disease

Understanding and identifying age groups who contracted and died from EVD is critical for determining the effect of planning public health response and interventions. Analyses of data from 2014 to January 2016 EVD outbreak revealed that there were differences in age between EVD cases and non-EVD suspected cases (Furuse et al., 2017). Furuse et al. (2017) found that women, the elderly, young children, and patients residing in the rural regions of Liberia were more likely to contract the disease and die because of the disease. Furuse et al. (2017) analyzed laboratory data from 10 EVD laboratories in Liberia that contained information on more than 16,000 samples that were tested for EVD between 2014 to 2005. A thorough review of the laboratory data identified a total of 10,536 patients of which 3,897 were EVD positive and 6,639 were negative for the EVD. Among the age groups of patients diagnosed with EVD or contracted EVD, there was an increase among children—ages less than 6 years; among ages 21-30; 31-40; 41-50; and >60 years (Furuse et al., 2017). Furuse et al. (2017) did not include households in which individuals with EVD died. Another weakness of this study was that over 601 cases were deleted from the analysis due to missing information about the patients' gender, age, and community of residence.

Johnson et al. (2016) discussed that the high rate of EVD transmission was observed in children <5 years old and suggested that young children are more vulnerable to be infected with EVD. Johnson et al. (2016) discovered that the risk for the spread of EVD was increased for children less than 2 years of age, for adults up to 35 years of age, and older adults 50 years and greater. Johnson et al. (2016) indicated in their study that highest risk for exposure to EVD among age groups was in contact with body fluids and contact with dead bodies. According to Johnson et al. (2016), over 50% of each age group had at least one or more direct exposure or contact with died bodies and body fluids.

Bower et al. performed a retrospective cohort study of all EVD survivors and transmission pattern discharged from an Ebola treatment facility to investigate deaths and the role of infecting dose in EVD in Sierra Leone. Bower et al. (2016) assessed risk factors and causes of late death from EVD by age, sex, exposure level, household risk factors, occupation, and date of onset. Bower et al. (2016) observed that nine-year-old child who was readmitted with virus infection (meningoencephalitis) tested positive for EVD after a polymerase chain reaction (PCR) test, one day after being discharged with previous negative blood tests. The authors noted that a six-year-old child who died one week after being discharged from a local hospital for severe productive cough and fluctuating pyrexia—tested borderline positive for EVD after a postmortem PCR analysis. Among patients with EVD, the authors found a high case fatality rate in the younger and older age groups. Bower et al. (2016) suggested that the differences in susceptibility of age pattern are critical in determining the outcome of EVD. The strength of the study by Bower et al. (2016) was the method used to follow-up participants for six to 13 months after discharged from the Kerry Town Ebola treatment unit so that late deaths will not be missed.

Fitzgerald et al. (2016) undertook a retrospective cohort study to examine and explain factors that contributed to the deaths of children admitted to 11 Ebola facilities during the 2014-2015 EVD epidemic. Fitzgerald et al. (2016) analyzed data stored in the Western Area Emergency Response Command Center (WAERC) database of 309 patients—children 2 days old to 12 years old that were positive for Ebola virus. Fitzgerald et al. (2016) explained that case-facility was 57% and 55% of the death from EVD took place in Ebola treatment facilities. Fitzgerald et al. (2016) observed that most deaths from EVD occurred three days after admission to Ebola treatment centers and was associated with younger age groups and diarrheal disease. The study retrospective study by Fitzgerald et al. (2016) is prone to bias, because a large proportion or percentage of the data was eliminated due to incomplete information on data points. The author did not provide any information on other age groups and other variables in their study. The study by Fitzgerald et al. (2016) did not include and sample size. The authors only presented a summary statistical analysis indicating the proportion of children affected by the disease.

Bah et al. (2015) was able to carry out a retrospective observational study examining the clinical presentation and out of patients with EVD in Conakry. Bah et al.

(2015) utilized Student's t-test, Fisher's exact test and the Wilcoxon rank-sum test to determine the association between EVD contraction and mortality and the clinical variables of age, occupation sex, and more. The authors cited that the median age of the confirmed cases of EVD was 38 years. Bah et al. found that the mean age of non-survivors of EVD was low. Bah et al. also found that the association between older age and a worse outcome among the patients with EVD often attributed to other co-existing conditions including infectious and chronic diseases.

Ji, Duan, Gao, Li, Ji, and Duan (2016) continued the discussion regarding the clinical features and outcomes of patients with EVD admitted to the Holding and Treatment Center of Jui Hospital from October 2014 to March 2015. Ji et al. (2016) conducted a retrospective observational study on a total of 773 patients with suspected cases of EVD—among which 285 were confirmed cases of EVD. The average and median age of the EVD patients was 29 ± 16 years and 28 years respectively. The youngest age was one month, and the oldest age was 80 years. Ji et al. discussed that 62 of 773 suspected case-patients were under the age of 16; 144 patients were between 16 and 35 years; 60 patients were between the age of 36 to 60 years; and 19 patients were above the age of 60 years. Statistical analyses were carried out utilizing SPSS Software to analyze the overall survival rate. Univariate and multivariate analyses were performed employing the logistic regression model, and the inter-group analyses were carried out employing Chi-square Test. The authors investigated the survival rate of EVD patients based on different age groups. Ji et al. found that the survival rate of EVD patients age group 0 to 6 years showed a statistically significant different lower than that of patients' age group 7 to 59 years ($p > 0.05$) or patient ≥60 ($p > 0.05$). Ji et al. indicated that the survival rates for patients' age group 7 to 59 and ≥ 60 years did not show any statistically significant different ($p = 0.6621$). The weakness of this study was that the authors did not include any discussion about how the sample was determined and selected. Sample size calculations are relevant in replicating the study for validity purposes.

In a similar study, Qin et al. (2015) conducted a retrospective observational study on 83 patients with confirmed cases of EVD who were hospitalized for clinical care at the Freetown China Friendship Hospital from October to November 2014. The study included clinical features of patients with confirmed cases of EVD including age, sex, date of onset, medical history, and more. Qin et al. (2015) indicated that 9 of the patients aged <10 years, 6 of them died from infection of the disease; 7 of the patients aged 10 to 20 years, only 3 recovered from the disease, while 4 of the patients died; 22 of the patients aged 21 to 30 years, 12 of them died from the disease. Among the 18 patients that were 31 to 40 years old, 16 of them died, and only 2 survived from the infection of the disease (Qin et al., 2015). The results showed that age and duration from the symptom onset were closely associated with the mortality of EVD (Qin et al., 2015).

Additionally, Ying-Jie et al. (2016) investigated the survival rate of EVD among patients based on different age groups. The study by Ying-Jie et al. (2016) included 285 patients diagnosed with EVD in different age groups —divided into three age groups. The three age groups consisted of age 0-6, age 7-59, and age 60 years and older. Ying-Jie et al. found that the survival rate for age 0-6 years showed lower statistically significant difference than that of age groups 7-59 years with $p = 0.00424$ and age groups 60 years and older with *p* =0.00447. The study by Ying-Jie et al. showed no statistically significant difference in the survival rates between age groups 7-59 years and groups 60 years and older with *p* =0.6621.

I analyzed and conducted a study looking at different age groups and EVD in Liberia. Little is known about factors that are associated with the contraction and spread of EVD among children (ages 0-14 years) in Liberia. Therefore, I will stress the importance of determining factors that are linked to the contraction and transmission of EVD among young people in Liberia. No study in Liberia has analyzed the association between young age groups and the contraction of EVD. According to a research study conducted Bangura, Bower, Johnson, Kamara, Kamara, Mansaray, and Glynn (2016), in Kerry Town Sierra Leone, young children experienced increased case fatality rate during the EVD outbreak in Sierra Leone.

EVD is a major risk to the lives and well-being of young children (Chérif et al., 2017). Chérif et al. (2017) conducted a retrospective cohort study among young children ages 0-19 years of age with confirmed laboratory case of EVD during the 2014-2015 EVD outbreak in Guinea. Chérif et al. found that the overall case fatality rate among children was 63%. Patients with younger age had a significant high increase of confirmed EVD cases and mortality with the adjusted OR = 0.995; 95% CI; $p < 0.05$. No study in Liberia has looked at the relationship between EVD and young age groups.

Community and County of Residence and Ebola Virus Disease

The 2014 outbreak of EVD in Liberia affected many communities and neighborhoods leading to several deaths and widespread transmission across the country

(CDC, 2015b). As the disease became to spread in different part of the country, travel-associated EVD cases were found in Spain, the United States, Nigeria, Mali, Senegal, and more (CDC, 2015b). Cases of EVD in Liberia were more prevalent in remote regions. Many of the people who contracted the disease in the capital city of Monrovia transmitted the disease to their respective communities—which led to sustained widespread of the disease that was difficult to eradicate because it was hard to reach communities and remote villages (Lindblade et al., 2015).

According to Fallah et al. (2015) more than 320 communities in Liberia were affected by the outbreak of EVD. The study by Fallah et al. (2015) pointed out the over 1.4 million people in Liberia lives in extreme poverty—making less than $0.50 per day with adult literacy rates under 43%. Lewnard et al. (2014) indicated that overcrowded urban locations and communities could present an increased risk for the contraction and transmission of EVD; because the disease can spread and can easily be contracted through the contact with body fluids including blood, urine, saliva, feces, semen, breast milk, and vomit from infected people.

The United Nations Statistics Division indicates that over 68% of the urban population lives in the network of slums—characterized by overcrowding, lack of basic sanitation, and high crime rates. Some of the communities that had high cases of EVD included the Doe Community, New Kru Town, Logan Town, Clara Town, Jallah’s Town, West Point, Slipway, Fiama, Crysaville, Mt. Barclay Town, Jacob’s Town, New Georgia, and more (Fallah et al., 2015). The counties in Liberia in which the contraction and transmission of EVD were more prevalent included Lofa County, Montserrado County, Bong County, Margibi County, and Bomi County. The rapid spread of the disease in these communities and counties in Liberia disrupted the rain-fed agricultural season, trade, school, and more (Abramowitz et al., 2015). The multiple outbreaks of the disease in remote districts, communities, and regions of Liberia were triggered or created because of people traveling from affected areas such as Montserrado and Lofa County and returning to their rural communities (Blackley et al., 2015).

In Liberia, Lofa County has one of the highest case fatality and cumulative incidences of EVD (Sharma et al., 2014). Approximately 632 cases of EVD in an estimated population of over 300,000 in Lofa County were reported by the Ministry of Health (Sharma et al., 2014). The outbreak of EVD in Lofa County counted for the third highest incidence rates in Liberia (Lindblade et al., 2015; and Sharma et al., 2014). The first case of EVD in Liberia was reported in Foya, a community of over 20,000 people in Lofa County (Sharma et al., 2014).

Montserrado County was one of the counties in Liberia that has the highest cases of EVD (Lewnard et al., 2014). According to Lewnard et al. (2014), over 1 million people live in Montserrado County—about 90% of the people in Montserrado County reside in Monrovia. Reducing the spread of EVD in Montserrado County was challenging because more than 75,000 people reside in Monrovia West Point Community slum without clean running water, access to healthcare centers, sanitation, and basic hygiene practices; making it difficult to implement public health initiatives and procedures to provide care to sick household members, performing hygienic burial, and preventing and controlling the spread of the disease (Lewnard et al., 2014). Lewnard et al. (2014) used a mathematical model to track susceptible, latently infected, infectious, people that have recovered from the disease, and individuals who have died of the disease.

The outbreaks of EVD in remote communities posed a significant challenge to county health teams to effectively investigate, isolate, plan, manage, and track the disease in these remote communities (Kateh et al., 2015). In July to December 2014, several outbreaks of EVD were detected in remote rural communities (Lindblade et al., 2015). Because of the difficulty in accessing medical care, limited telecommunications coverage and low levels of health education in remote communities—the introduction of EVD led to several multifaceted outbreaks necessitating a prompt and coordinated public health response to stop the spread and contraction of the disease (Lindblade et al., 2015). Lindblade et al. (2015) found a 94% decrease in the contraction or transmission of EVD after the initiation of community-based interventions in the outbreaks of in 9 remote rural communities of Liberia from August to December 2014.

Abramowitz et al. (2015) conducted a similar study to examine how much local Liberian communities knew about the spread of EVD. The authors analyzed data from the 2014 EVD outbreak in Montserrado County to study how communities in Montserrado County managed the outbreak when they there was limited access to care due to the rapid closures of clinics and hospitals. Abramowitz et al. (2015) found that communities in and around Montserrado County responded to the outbreak in several ways that supported and discouraged formal efforts to manage and contain the rapid spread of the disease. The widespread distribution of the virus in urban and rural communities posted significant challenges; therefore, intensified case identification and contact tracing were needed to help minimize the spread of the disease (Nyenswah et al., 2014).

Despite the declined and eradication of EVD cases in Liberia, an increase in the level of interventions is needed to eliminate EVD outbreaks in remote areas (Nyenswah et al., 2014). Early case recognition, detection, and isolation were needed to rapidly contain the outbreaks in hard-to-reach and newly affected communities (Nyenswah et al., 2015). Nyenswah et al. (2015) investigated the cluster of EVD in Bong and Montserrado County, two of the largest counties in Liberia, utilizing data from collected from interviews, laboratory results, case reporting forms, and treatment records. The authors highlighted that challenges associated with public health measures to disrupt and stop the spread and contraction of EVD were due to the cluster of EVD in Bong and Montserrado County. The delay in the detection and ineffective contact tracing took place in EVD cluster locations because family believed that that mandatory cremation and property destruction in Monrovia harmed the process of contact tracing and delayed EVD detection (Nyenswah et al., 2015). For this reason, family members who sought care in Monrovia, drove 4 hours in public transport from their homes to seek medical care in Bong County—distance of 123 miles (Nyenswah et al., 2015).

In March 2014, the outbreak of EVD spread through the Firestone community in Liberia (Reaves, Mabande, Thoroughman, Arwady, & Montgomery, 2014). Firestone is one of the world largest producer of rubber with the population of over 69,000 people (Reaves et al., 2014). Reaves et al. (2014) conducted a study in Firestone Liberia to analyze the cases of EVD at Firestone facilities. The cases of EVD among the residences of Firestone included 71 EVD cases in 39 families, of which 57 were confirmed positive for the contraction of virus (Reaves et al., 2014). Reaves et al. (2014) indicated that 53 (80%) of the case of EVD were fatal, of which 39 were confirmed cases including 27 (69%) confirmed cases at Ebola treatment units, 6 (15%) cases at the main health center in Firestone, and 6 (15%) in the community.

The experience of the outbreak in the Firestone communities provided public health professionals and healthcare providers successful strategies for disrupting and reducing the risk factors associated with the contraction and transmission of EVD (Reaves et al., 2014). The response to the outbreak in Firestone included a rapid establishment of an incident management system; immediate isolation of EVD patients in Ebola treatment units; an enhanced active and passive surveillance of the disease; allowing for voluntary quarantine for exposed individuals; and management of contacts based on the nature of individuals' exposure to the disease (Reaves et al., 2014).

The spread of EVD in remote Liberian communities was due to delays in care for patients who did not have ambulance support to accessing Ebola Treatment Units (Blackley et al., 2015). During the outbreak of EVD, most of the remote communities in Liberia was accessible only by canoe and long-distance walk by foot. In October 2014, the Ministry of Health, CDC, and other non-governmental organizations (NGOs) investigated the outbreak in remote villages by providing ambulance support to help patients who managed to walk out of their villages to access Ebola treatment units (Blackley et al., 2015).

Funeral Attendance (Burial Rituals) and Ebola Virus Disease Contraction

The exposure to funeral or burial ritual is known to be one of the risk factors associated with the contraction and transmission of EVD (Agua-Agum et al., 2016). Most communities are West Africa including Liberia believe in funeral and burial practices—as they are perceived as a critical step in transitioning from the physical world of living to the spiritual world (Manguvo & Mafuvadze, 2015). It is widely believed in most West African nations that the transition from one life to another should be facilitated by surviving family members or close relatives through funeral and burial rituals including the washing of dead bodies, dressing the dead bodies of their love ones in traditional clothes, and close contact with the dead bodies (Manguvo & Mafuvadze, 2015). Considering that one of the main means of human-to-human contact and spread of EVD is through direct contact with dead bodies including funeral and traditional burial practices and contact with infected body fluids (Manguvo & Mafuvadze, 2015). The contact with dead bodies is a significant source of the virus at high concentration and must be handled with precautionary measures (Vetter et al., 2016).

Caleo et al. (2018) undertook a cross-sectional study to analyze and examine factors affecting the dynamics of EVD transmission and contraction and community compliance with EVD control measures over a period. Caleo et al. (2018) conducted a mixed-methods study to examine factors associated with the contraction and transmission of EVD in a remote district in West Africa (Kailahum District). The study population consisted of 240 households (1161 individuals). Caleo et al. (2018) noted that household size ranged from 1 to 17 people—with a median household size of 5. Caleo et al. (2018)

found that 48% of household cases of EVD had a history of contact with symptomatic patients and a funeral exposure with dead bodies. Olu et al. (2016) further opined that people who had multiple contacts with dead bodies, washing of corpses, and funeral attendance accounted for 80% of EVD cases and were below 35 years of age. Majority of the contacts at funerals and with dead bodies were linked to the confirmed cases of EVD (Olu et al., 2016).

Additionally, Agua-Agum et al. (2016) discussed factors related to the exposure pattern driving the contraction and transmission of EVD in West Africa. Agua-Agum et al. (2016) undertook a retrospective observational study to examine factors driving the transmission and contraction of EVD—analyzing data from 5,343 cases of EVD in Liberia, 10,746 in Sierra Leone, and 3,529 cases in Guinea. The cases driving the outbreaks of the disease included funeral exposure and nonfuneral exposure. The authors found that 25% of EVD cases reported exposure at funerals (Agua-Agum et al., 2016). Agua-Agum et al. (2016) found that most of the people that reported contacts at funerals also reported one or more non-funeral contacts.

Coltart et al. (2017) indicated that safe burial and avoiding rituals that require the handling of the dead or washing the body of EVD patients for burial are essential strategies to preventing the contraction or transmission of EVD during an outbreak. During the EVD outbreaks in Liberia, most tribal ceremony rituals were closely held in secrets (Coltart et al., 2017). One of the key funeral rituals that were common to all traditional groups in Liberia was that washing dead body with bare hands and spending time with the dead—which was highly contagious in the case of EVD outbreaks (Coltart et al., 2017). The populations that were affected by the outbreaks of EVD consisted primarily of Muslims and Christians. To prepare dead bodies for funerals, Christians will close their eyes, wash, and dress their dead; while Muslims will wash the dead and wrap the dead in a white cloth (Coltart et al., 2017).

Brainard, Hooper, Pond, Edmunds, and Hunter (2015) performed a meta-analysis to examine the risk factors for the contraction of EVD. Scientific research articles were searched to screen for information about the transmission or contraction of EVD. Data from these articles were extracted from scientific research articles and summarized with meta-analysis (Brainard, Hooper, Pond, Edmunds, & Hunter, 2015). Brainard et al. (2015) found that caring for a person with a suspected or probable case of EVD and participation in traditional burial were strongly linked with contracting or acquiring the disease. Brainard et al. (2015) also found that the increase and high degree of direct physical contact with affected cases or the dead were linked to the contraction and transmission of EVD.

In summary, funeral attendance and practices pose a substantial risk for the transmission of EVD, which may increase with viral load—the highest in nonsurvivors during the late stages of the progression of the disease and at death (Curran et al., 2014; Lever & Whitty, 2016). The traditional practices of washing, preparing and touching dead bodies including direct and prolonged contact with a dead body pose a significant risk for EVD contraction and transmission (Curran et al., 2014). EVD infection around funeral rites and traditional preparation of dead bodies were critical for the spread and contraction of the disease (Lever & Whitty, 2016). Curran et al. (2014) agreed with Lever and Whitty (2016) that persons or patients that died of EVD are possible key source of EVD infection and at least one-third of the outbreaks of EVD have reported the spread and contraction of the virus involving funeral rites and rituals and the traditional preparation of dead bodies that involve close contact with dead bodies.

Exposure to Body Fluids and Ebola Virus Disease

EVD can be transmitted or spread through human-to-human via direct contact with body fluids including blood, secretions or mucosal exposure to body fluids, breast milk, saliva, and stool of a person who is sick with the disease (Rewar & Mirdha, 2015). The incubation period after human-to-human contact with body fluids from infected patients is 1-21 days and patients are not considered contagious or infectious until they develop the symptoms of EVD (Beeching, Fenech, & Houlihan, 2014). Human-to-human infection transmits a high case fatality rate depending on the quality of supportive care and the species of EVD (Beeching, Fenech, & Houlihan, 2014). According to Beeching, Fenech, & Houlihan (2014), most cases of EVD result from close contact with body fluids and close physical contact.

Bausch et al. (2007) carried out a study that tested clinical specimens from 26 confirmed laboratory cases of EVD collected from Ebola isolation units. The study was conducted in an isolation unit at a local regional hospital during the outbreak of EVD in 2000, in Uganda. The Ebola isolation unit was divided into patients with suspected and probable cases of EVD (Bausch et al., 2007). Samples of stool, urine, blood, vomit, and saliva were collected at the patients’ bedsides. The virus was analyzed using reverse-transcription polymerase chain reaction (RT-PCR) and virus culture technique in 16 to 54 clinical specimens from body fluids including semen, breast milk, blood, saliva, stool, and a skin swab (Bausch et al., 2007).

Bausch et al. (2007) found that 16 clinical specimens from 26 patients were positive by RT-PCR, including 8 of 16 saliva samples, 1 of 11 skin swab, 2 of 4 stool samples, 1 of 2 semen, 2 of 2 breast milk, and 1 of 1 nasal blood sample. The authors also found that urine, sputum, vomit, and sweat was negative by RT-PCR for EVD (Bausch et al., 2007). The authors elucidated that EVD in human breast milk raises the possibility for mother-to-child transmission of the disease. Bausch et al. (2007) found that mothers whose breast milk samples were tested with their children, in this study, died of laboratory-confirmed EVD during the early stages of the outbreak in Uganda. Glynn, Bower et al. (2017) explained that the highest level of EVD contraction or transmission was direct contact with body fluids and touching the body of people that died of EVD, however no evidence of association was found between the case fatality of EVD and the extent of bodily fluids exposure.

Vetter et al. (2016) carried out a study to understand the key factors of EVD transmission necessary to control the spread of the disease, implement control measures to protect healthcare workers and eradicate the spread of the disease in communities. Vetter et al. (2016) indicated that EVD RNA takes 22 days in saliva after onset, stool takes 29 days after onset, 33 days in virginal fluid, 44 days in sweat, 38 days in amniotic fluid, 9 months in cerebrospinal fluid, 16 months in breast milk, and 18 months in semen. Another study by Lever and Whitty (2016) explained close contact with people that are symptomatically infected with the virus and their body fluids including blood, stool, and vomit is required for the spread and contraction of all species of EVD infecting humans.

During the early stage outbreak of EVD in the Democratic Republic of the Congo, when Ebola was first discovered to be known as a fatal and deadly infectious disease to human. Dowell, Mukunu, Ksiazek, Khan, Rollin, and Peters (1999) conducted a cross-sectional study to investigate the risk factors among family members in the Democratic Republic of the Congo. Dowell et al. (1999) indicated in their study that, of the 173 households contact of primary cases of EVD, 16% developed EVD—among those with direct contact and exposed to body fluids presented a risk of EVD contraction and transmission (RR, 3.6; 95% CI, 1.9-6.8).

A retrospective study was undertaken by Francesconi et al. (2003) to identify some of the risk factors associated with EVD transmission in Uganda from August 2000 through January 2001. The outbreak of EVD in Uganda was a large outbreak with 425 cases and 224 deaths (Francesconi et al., 2003). Francesconi et al. (2003) noted in their findings that the contact with body fluids showed a strong correlation with a crude and adjusted prevalence proportion ratios (PPR) of 5.30, 95% CI 2.14 to 13.14. Also, the authors mentioned that direct physical contact with a sick person was linked to the spread of the disease (PPR = 3.53, 95% CI 0.52 to 24.11). Human-to-human spread of the disease occurs through contact with body fluids of a symptomatic infected individual while providing care in health care centers, at home, and during traditional burial rituals (Lindblade et al., 2015).

According to the CDC (2016), the Ebola virus RNA levels in body fluids including blood increased significantly during the acute phase of the disease. During the outbreaks in Liberia, Guinea, and Sierra Leone, significant numbers of EVD patients had severed vomiting (68%), diarrheal disease (66%), and bleeding (18%) —in the late phase of the disease (CDC, 2016). Family members, healthcare workers, other caregivers, and people who handle bodies of patients that died from EVD without access to the appropriate personal protective equipment are at high risk for contracting and being exposed to the virus (CDC, 2016). The EVD RNA levels in the blood of patients who have died from the disease are on average 2 $\log_{10}$ higher than the copy of RNA levels in patients that survived from the virus (CDC, 2016).

Contact with the Living Sick and Ebola Virus Disease

According to the WHO (2018), EVD can be spread or contracted through person-to-person contact via direct contact with a living sick person. People and healthcare workers are infected with the virus while providing care and treating patients suspected or confirmed with the disease (WHO, 2018a). Most of the EVD infection among family and healthcare workers have come as the result of providing care and contact with suspected and confirmed patients—where infection control protocols or precautions are not fully practiced (WHO, 2018a). A research study by Dietz et al. (2015) elucidated that 48% of the participants in their study reported having contact with patients with a suspected case of EVD or with a living sick person. Dietz et al. (2015) noted that out of 8,311 participants in the study, 4,885 (59%) confirmed that they had contact with a suspected case-patient or a sick patient within one month of EVD symptom onset. Dietz et al. (2015) indicated that out of 4,885 participants, 558 (11%) reported contact with a critically ill patient.

Olu et al. (2016) carried out a descriptive study to examine EVD contact tracing activities—utilizing a mixed method design form June 2014 to August 2015 in Sierra Leone. The mixed methods design included secondary data analysis, a review of reports, and key informant interviews (Olu et al., 2016). The study by Olu et al. (2016) consisted of 3,838 confirmed cases of EVD and 32,706 contacts with ill patients with EVD. Olu et al. (2016) discussed that 852 (22%) of the confirmed cases of EVD listed as contacts at the early onset of the disease. Olu et al. (2016) explained that most of the contacts with ill individuals, about 52.5%, were closed neighbors of the confirmed cases of EVD, while 38% were linked to family members. In a similar study conducted by Wolfe et al. (2017) in Liberia further orated contacts with a sick person in identifying people who have been in contact with confirmed cases of patients with EVD. Wolfe et al. (2017) discussed that 168 contacts associated with confirmed cases of EVD were found among 73 households within four districts of Montserrado County in Liberia. Wolfe et al. (2017) found that 45% of contacts with living sick persons were males, with ages of contacts ranging from 2 weeks old to 72 years—with a median age of 14 years.

Bah et al. (2015) performed a retrospective observational study of patients with suspected cases of EVD who were admitted at an Ebola care center in Conakry from March to April 2014 to examine the clinical presentation of patients of all ages with EVD. The results of the retrospective study showed—out of 80 patients who had symptoms of suspected cases of EVD admitted to the Ebola treatment centers, 37 patients were confirmed to have EVD, 36 through RT-PCR and one tested positive for IgG antibodies. Bah et al. (2015) concluded that the most common means of close contact was closed contact with other patients with confirmed cases of the disease and through household clusters. According to Bah et al. (2015), contacts by way of household clusters accounted for 23 (62%) of the confirmed cases of EVD.

Literature Review Summary

Understanding multiple risk factors that relate or link to the contraction of EVD in Liberia is critical to preventing and controlling the spread, magnitude, and duration of EVD outbreaks (Furuse et al., 2017). To fully understand the outbreak of EVD, it is essential to examine and understand multiple risk factors, not limited to one or two, associated with the outbreaks of EVD—to have a fuller understanding of the epidemic in Liberia. All the variables described in this study were thoroughly discussed in detail to help establish relationships between the dependent (EVD contraction) and independent variables (age, sex, funeral attendance, contact with body fluids, county and community of residence, and contact with sick persons).

In this literature review, there is enough evidence for the literature that understanding the factors that lead to the outbreak of EVD can minimize the spread of the disease (Francesconi et al., 2003; Beeching, Fenech, & Houlihan, 2014; Olu et al., 2016; Brainard et al., 2016; Caleo et al., 2018). Based on the review of the literature, secondary data from the NPHIL, collected at various Ebola Treatment Units in Liberia, was used to examine the association between the factors associated with the outbreak of EVD and the contraction of EVD. Although the outbreak of EVD in West Africa started in December

2013 from Guinea (Mohammed et al., 2015), not all the nations that were affected by the outbreak began the same time. According to Furuse et al. (2017), the outbreak of EVD in Liberia began in March 2014 and ended January 2016—while the outbreak of EVD in Nigeria was brief and started on July 23, 2014, and ended by December 2014 (Otu et al., 2017). The unprecedented spread of the disease across the West African nations of Guinea, Liberia and Sierra Leone was advanced by the fact that these nations had never experienced an outbreak of EVD and were not prepared to handle disease at every level due to poor public health and healthcare facilities and the lack of resources (Out et al., 2017). The response to the outbreak of EVD in Nigeria was swift due to developed public health and healthcare infrastructures and resources in place that provides communities the ability to minimize the spread of disease (Alli, Nwegbu, Ibekwe & Ibekwe, 2016).

Definition of Key Terms Related to the Study

The following terms are defined as they relate to the study to help clarify their usage throughout this study. The EVD outbreak-related case definitions that are used in this study include:

Ebola virus disease (EVD): A severe, often fatal disease that causes a serious hemorrhagic fever in human being with significant outbreak probability and high case fatality rates (NPHIL, 2017). The severity of the EVD can lead to multi-organs failure and death, with an overall fatality rate of 50-90% (Dietz et al., 2015).

Contraction of Ebola virus disease (outcome or dependent variable): Patients who tested positive for EVD via laboratory test—utilizing EVD RNA by reverse transcriptase-polymerase chain reaction (RT-PCR). Based on the secondary data obtained for this study, those who contracted the disease or tested positive for EVD RNA were used as my outcome variable.

Confirmed cases of EVD: Cases of EVD confirmed by laboratory testing with the detection of EVD RNA by RT-PCR or IgM antibodies against EVD (Coltart et al., 2017; Furuse et al., 2017); people who were tested positive for the virus with RT-PCR test specific for EVD were labeled as confirmed cases of EVD (Dietz et al., 2015).

Suspected cases of EVD: Patients who are alive or dead, suffering, or have suffered from a sickness characterized by a history fever, vomiting, stomach pain, headache, nausea, anorexia, difficulty breathing, and more (Coltart et al., 2017; Furuse et al., 2017). Suspected cases of EVD are patients with a sudden onset of fever have had contact with a suspected or confirmed EVD case (Coltart et al., 2017). Suspected case-patients are patients with unexplained bleeding episodes or any sudden and unexplained death (Coltart et al., 2017).

Exposure: An event that was reported by a suspected or confirmed case-patient in which case came in close contact with a sick person or a dead person (NPHIL, 2017).

Funeral attendance or funeral exposure: Exposure that involves touching of the dead and attendance at a funeral (NPHIL, 2017).

Contact with the sick: When a person came in close contact with a suspected or confirmed case-patient. Contact with an infected person is defined as a person who took unprotected care of a patient with EVD or participated in washing the linen of a suspected case-patient bathing a patient or slept in the same room with a case-patient.

Contact with body fluids: When a person took unprotected care of suspected or probable case-patient with unexplained bleeding, vomiting, diarrheal disease, body waste or stool, and more (NPHIL, 2017). Research evidence from the outbreaks of EVD in West Africa suggests that the virus built resistant in various compartments and fluids in the body (Vetter et al., 2016). Direct contact with body fluids is also defined by a case-patient who has EVD with diarrhea, vomiting, and bleeding Bower et al., 2016).

Age or age groups: The years of life at the time when the patients' history and laboratory test were carried out and stored in the database for research purposes. Age is the time between the day the participants were born and the time they were admitted to the Ebola treatment units and diagnosed with EVD. Age groups will be defined by 0 = 1-4 year; 1 = 5-9 years; 2 = 10-14 years; 4 = 15-19 years; 5 = 20-24 years; 6 = 25-29 years; 7 = 30-34 years; and 8 = 35-39 years; 9 = 40-44; 10 = 45-49; 11 = 50-54; 12 = 55-59; 13 = 60-64; and 14 = >65 years. Age will be measured as a categorical variable.

Gender: In this study, male and female. Gender differences among male and female described how the roles of gender could influence the pattern of exposure to infectious diseases. Gender will be defined as a categorical (sometimes called a nominal variable) (male and female).

Community or county of residence: The location where the disease was contracted or transmitted either by direct or indirect contact with body fluids, participating funeral rites, washing dead bodies, and more.

Assumptions

In analyzing whether the contraction or spread of EVD is associated with funeral rites or burial rituals, exposure to body fluids, contact with sick patients, age, gender, and community of residence in Liberia, I will rely on the use of secondary data collected by the Ministry of Health on patients admitted at Ebola treatment centers in Liberia. As a result, the following assumptions characterized this research study: One of the key assumptions of this doctoral study is that the data collected from the various Ebola treatment centers will contain data that are representative of all suspected, probable, and confirmed cases of EVD in Liberia within the specified period. Because the data have been validated by the NPHIL, the Ministry of Health of Liberia, NIH, WHO, and more, I assumed that the data collection and recording processes and history obtained from patients were accurate and correct. It can also be assumed that all patients' information and laboratory results were recorded and reported in a timely manner in the data surveillance system.

Scope and Delimitations

The scope of this doctoral study is a descriptive retrospective cross-sectional study, and the conclusions can be generalizable to Liberia. This study focused primarily on data collected from patients that were admitted for a suspected or probable case of EVD during the EVD epidemic in Liberia. The primary focus of this doctoral was to look at the risk factors associated with the contraction of EVD among a cross-section of patients admitted or seen at Ebola treatment facilities in Liberia. There are numbers of studies in the literature on EVD that have addressed these issues, yet little is known about multiple risk factors that are linked to the EVD outbreaks in Liberia including the age groups and gender. It is important to take a broader perspective looking at multiple factors that were associated with the outbreaks of EVD in Liberia. Measuring the risk levels for factors such as funeral rites or rituals, contact with body fluids, contact with a living sick person, age groups, gender, and community of residence that have been identified as among the major causes of the contraction or transmission of EVD can serve as a baseline for placing emphasis on additional public health interventions.

This study was based on a secondary data collected or recorded during the EVD crisis among patients admitted at Ebola treatment centers in Liberia without any opportunity for primary data collecting and analysis. Therefore, only variables that are in this data was analyzed. In this study, I included data only on the EVD outbreaks among a cross-section of patients that were enrolled and admitted to Ebola treatment units between the years 2014 to 2015. This study was delimited to the dependent and independent variables that will be included in the secondary dataset selected for this study. This study will confine itself to the number of research questions that will be addressed in the dataset.

Although the data includes other variables in the dataset, I did not analyze or use variables that are not included in my research questions and hypotheses testing. Due to the scope of this study, risk factors such as sexual intercourse with suspected case-patients, patients' socioeconomic status such as educational achievement, income, and occupation weren't analyzed in this study—these variables were not collected nor reported in the dataset. This study was limited to the 2014 outbreaks of EVD in Liberia, despite other countries like Guinea and Sierra Leone were affected by the outbreaks.

The most important problem for a researcher was to show that dependent or outcome variable is not influenced by any outside force other than those the researcher put in place to investigate which may create a thread to validity. According to Kukull and Ganguli (2012), a careful data collection, study design, and suitable or proper data analysis are important to any research internal validity. The concept of missing data or missing values in the data is critical to understand how to manage data effectively. Utilizing an appropriate technique to handle cases with missing data when performing secondary analyses is crucial to reducing biases, reporting inaccurate results, and reaching an invalid conclusion (Langkamp, Lehman, & Lemeshow, 2010). Missing data can be defined as the data value that is not accounted for and stored for a variable of interest in the observation of the dataset (Kang, 2013). Even with a well-designed research study, missing data often occurs in nearly all research studies (Kang, 2013). If the missing values in the dataset are not accounted for by the researcher, he/she may report out or conclude an inaccurate finding of the study (Kang, 2013). Due to improper handling of data, the findings or results obtained by the researcher will be different from ones where the missing values are present (Kang, 2013).

Not all cases of EVD were recorded and reported in the secondary dataset provided by the NPHIL. The data in this study were either self-reported or reported by family members or friends or inferred by the interviewers and may contain biases. For instance, some of the patients may recall the exposure to body fluids or funeral rituals in more detail or have different takes of what constitutes exposure to body fluids and contact with suspected case-patient. Generalizing the findings of this study, I recognize the unique nature of the outbreak in Liberia including safe funeral practices, behavior change, community mobilization, and more.

The generalizability of this research was limited to Liberia. My analysis provided a quantitative basis for risk factors measures against the contraction and spread of EVD in Liberia. The outcome or result of this study may produce the same result when applied in different settings.

Significance of the Study and Implications for Positive Social Change

The key to preventing future outbreaks of EVD is to identify risk factors that increase the risks of EVD contraction. The findings of this study provided insights and shed light on the most important risk factors associated with the contraction of EVD. Also, the findings of this study provided insights and help public health and healthcare professionals regarding key factors that contribute to the spread and contraction of EVD. This study can provide ways to prevent and reduce the incidence, contraction, and spread of EVD during an outbreak especially in Liberia. I examined how the risk factors associated with EVD differ according to age, sex, community and county of residence, contact with a living sick person, contact with dead bodies, and funeral attendance.

The findings of this research study, if implemented, may lead to significant implications for positive social change policies and practices in Liberia—being that even years after the elimination of EVD, no study has been conducted in Liberia to examine multiple risk factors associated with the contraction of EVD. Understanding the relationship between these risk-associated factors will help decision-making process for healthcare and public health professionals and policymakers involved in the concentration of resources, program planning and implementation in areas that might have the most significant impact on EVD prevention, treatment, and control.

Also, I analyzed and conducted a study looking at different age groups and the contraction of EVD in Liberia. Little is known about the contraction and spread of EVD among children (ages 0-14 years) in Liberia. Therefore, I highlighted the importance of determining factors that are linked to the contraction and transmission of EVD among younger people in Liberia. No study in Liberia has analyzed the association between younger age groups and EVD. According to a research study conducted by Bangura, Bower, Johnson, Kamara, Kamara, Mansaray, and Glynn (2016), in Sierra Leone, young children experienced increased case fatality rate during the EVD outbreak in Sierra Leone. At the same time, the findings of this research pinpoint and determine characteristics for the segment of the population that are vulnerable or at higher risk of contracting the spread of any future outbreak of the disease in Liberia. In so doing, providing relevant, reliable, and verifiable public health information would guide local, state, and nationwide policies and programs aimed at improving EVD awareness and strengthen disease surveillance system in detecting EVD cases.

Finally, this retrospective cross-sectional study examined factors that will minimize the spread of EVD through contact tracing, good hygiene practices, and raising awareness of the risk factors associated with EVD, and implementation of an alert and response system as the means for identifying individuals with possible EVD. The alerts, and response system will include a national Ebola hotline and EVD social media sites on Facebook, Facebook Messenger, and WhatsApp that will help report any suspected cases of EVD. Propose policy that will mandate safe and healthy practices in schools, community gathering, healthcare settings, public and private burial sites, and more. Education about safe hygiene practices in rural regions of Liberia. Keeping abreast of current research findings regarding the spread of the disease and strategies for prevention is critical for a successful disease prevention program. The findings of this study will help buttress future investigations and may lead to a deeper understanding about the contraction of EVD in Liberia. The results of this study will be used to create public health interventions to raise awareness about the disease—so that people will understand how the virus is transmitted or contracted. Understanding the factors that contribute to EVD is paramount in any EVD program prevention and control initiatives.

Significance to the Theory

In this section, I utilized the SEM theoretical framework that was adapted and first employed by Bronfenbrenner (1979) and later modified by Baral et al. (2013) and the CDC (2015a) to cancer screening initiatives and the assessment of HIV risk factors. The data on EVD allowed for multilevel analyses retrospective cross-sectional data containing hospital records including individual, family, and community history of contact with suspected case EVD persons, laboratory findings, and self-reported information for patients admitted to Ebola treatment facilities in Liberia—making the application of the SEM theoretical framework practicable or achievable.

Summary and Conclusions

In this section of the study, I provided a comprehensive review of the literature and literature search that included keywords, terminology, and inclusion and exclusion process that are associated with the outbreak of EVD in Liberia. Liberia was one of the nations in West Africa that experienced the unprecedented outbreaks of EVD. The outbreaks of EVD in Liberia resulted in more than 11,000 cases of the disease and over 4,800 deaths (Raftery, Condell, Wasunna, Kpaka, Zwizwai, Nuha, Nyenswah, 2018). Despite the eradication of EVD in West Africa including Liberia, the disease remains a threat and may not be the last outbreak of a disease (Raftery et al., 2018). In this section, I discussed in detail the following: the problem statement; research questions and hypotheses testing including the key variables that will be used in the study; I justified the application of the SEM as the theoretical framework of this study; and the nature of the study. I concluded this section with a complete description of the significance of the study and the implications for positive social change that are consistent with and delimited by the scope of the study.

In section 2, I will focus on the methodology and design that will be used in this study. I will focus on the methodology and study design based on the retrospective cross-sectional data that has been supported by current literature. Section 2 will describe the methodology that will be used to analyze the secondary data, the study population, sampling and sampling procedures, and design of the study.

Section 2: Research Design and Data Collection

Introduction

The primary purpose of this quantitative research was to investigate risk factors that are associated with the outbreak of EVD contraction in Liberia. Several factors influence the contraction and spread of EVD including the exposure to funeral rites, exposure to body fluids, exposure to a sick person, and more (CDC, 2017). Knowing and understanding factors that are associated with the contraction and spread of the disease is critical, prompting the need for this research study. Identifying the risk factors of EVD contraction could help guide public health interventions and target public health resources during an outbreak of EVD. In this study, I used a retrospective cross-sectional design by analyzing secondary data collected on patients admitted to Ebola treatment units in Liberia. In section one, I provided a review of current literature on key variables of this study including the geographical location and population of Liberia, the epidemiology of the outbreak of EVD in Liberia, factors associated with the contraction of EVD including age, gender, community and county of residence, funeral attendance, exposure to body fluids; and close contact with the living sick persons.

In this section, I discuss the research design in connection with the research questions and rationale including the study variables (dependent and independent variables). I also discuss the methodology that was used in this research including components such as the target population, sampling and sampling procedures employed to collect the data, instrumentation, operationalization of the variables, ethical procedures, and the threats to validity.

Research Design and Rationale

For this research study, I used a retrospective cross-sectional design to analyze secondary data collected during the 2014 to 2015 outbreaks EVD on patients admitted to various Ebola treatment facilities in Liberia. Cross-sectional study design was appropriate for this study because it allows a researcher to examine association at a single point in time and measure contact or exposure prevalence in connection with the disease prevalence (see Aschengrau & Seage, 2014). According to Smith et al. (2011), the use of a retrospective cross-sectional study can be less expensive and less time-consuming regarding data collection because the data are available based on the primary data collection organization or site.

This study design allows researchers to take a snapshot of a defined population at one point in time and measure the prevalence of the disease about the prevalence of the exposure (see Aschengrau & Seage, 2014). For instance, utilizing this design provided the opportunity to investigate the association between risk factors and the contraction of EVD among patients admitted at various Ebola treatment facilities in Liberia. One unique characteristic of a retrospective cross-sectional study is that its results are highly generalizable based on the sample of the general population (Smith et al., 2011).

Methodology

In this section, I define and describe the target population and study area, the sampling and sampling procedures that I used to collect the data in the secondary data materials of the study including the calculation of the sample size or power analysis. I also elaborate on the instrumentation and operationalization of the variables, data analysis plan, the threats to validity, and ethical procedures of the study.

Study Population

The target population in this study comprised a cross-section of patients, all ages, both males and females, admitted to Ebola treatment units during the 2014 outbreak of EVD in Liberia. Liberia is a relatively dense nation located on the west coast of Africa and bordered by Guinea, Ivory Coast, and Sierra Leone (WHO, 2016). Liberia is one of the smallest and lowest-income nations in Sub-Saharan Africa with a population of more than 4.6 million people (WHO, 2016). According to the WHO (2016), more than half of the population in Liberia lives in the urban areas, with one-third of the total population residing within 40 to 50 miles of Monrovia, the capital city of Liberia. Liberia is a low-income nation that went through 14 years of civil wars with significant impact on the healthcare system, the disease surveillance system, and the health workforce, which contributed to the lack of achievement of the Millennium Development Goals (Keys et al., 2015).

Sampling and Sampling Procedures

Secondary analysis of existing data has become the most popular method for improving the overall efficiency of health science research (Cheng & Philips, 2014). The effort of accessing secondary data depends on the collecting agencies, funding institutions, and governmental agencies to help make the data collection in primary research studies and health-related data registry systems available to researchers who did not participate in the original data collection or research and in the maintenance of the data registry systems (Cheng & Philips, 2014). Secondary data can be private or public data set that is provided by collecting agencies or by institutions funding the data. To help maximize the output of the data, researchers must weigh the data by assessing the variables needed to answer their research questions and study hypotheses (Cheng & Philips, 2014).

The data used for this doctoral study was provided by the NPHIL. The data was secondary data collected from Ebola treatment units by public health and health care professionals during and after the outbreak of EVD in Liberia in 2014. The design of this study required the utilization of secondary data collected by the Liberia Ministry of Health. During the outbreak of EVD, several public health agencies including the Ministry of Health of Liberia, WHO, the CDC, the NIH, and other international agencies collected data in communities, counties, and Ebola treatment units for surveillance and public health response purposes. The NPHIL was established in 2016, after the 2014 outbreak of Ebola in Liberia. The unprecedented outbreak of Ebola claimed the lives of over 11,000 people and infected more than 28,000 people (NPHIL, 2017).

In collaboration with the Ministry of Health of Liberia, NPHIL collected data in more than six counties and over 100 communities in and around Liberia (NPHIL, 2017). NPHIL worked with other international organizations including the CDC, NIH, WHO, and others to strengthen existing infection prevention and control efforts, surveillance laboratories, infectious disease control, public health capacity building, and monitoring and rapid response to outbreaks of infectious diseases (NPHIL, 2017). The secondary data obtained from NPHIL included patients’ age, sex, community and county of residence, contact with dead bodies, funeral attendance, and contact with a living sick person record. The dataset from the outbreak of EVD was collected from Ebola treatment units during the EVD outbreaks in Liberia.

To ensure the quality of the secondary data, the dataset was analyzed utilizing the IBM SPSS Statistic 25. SPSS was used to analyze the data, check for missing data in the dataset, and more.

Sample frame. The sampling frame included deidentified patients' ID number, county of report, Ebola treatment unit, ages of patients, gender, and patients' history on contact with sick individuals, exposure to body fluids, and funeral attendance and burial rituals, along with patients' county or community of residence and EVD status (laboratory findings). The sample did not include the socioeconomic status such as income, educational achievement, and occupation of the patients. The sample population included people who were tested and screened for virus admitted at different Ebola treatment facilities in Liberia.

Data accessibility and permission. To gain access to the data, I obtained a data use agreement and letter of confidentially or permission to use the data signed by the NPHIL coordinator and approved by the Institutional Review Board (IRB). After I defended my proposal, I was granted permission from the IRB to use the secondary dataset from the outbreak of EVD in Liberia. See Appendix A for a copy of the data use agreement and letter of confidentially and permission to use the data.

Power analysis/sample size calculation. I made use of the OpenEpi version 3 by Dean, Sullivan, & Soe (2014) to calculate the sample size power of the population in this study. OpenEpi is a free web-based operating system independent series that provides a number of epidemiologic and statistical tools for data summary designed for use in medical and health science research (Sullivan, Dean, & Soe, 2009). The OpenEpi has the capability for calculating sample size for cross-sectional studies, cohort, case-control, comparisons of two means, and randomized controlled trials, as well as power calculations for proportions such as cross-sectional studies, case-control, cohort, clinical trials, and for comparisons for two means (Sullivan et al., 2009). Because the independent variable might have affected the dependent variable in a different way, I used the cross-sectional design model of the OpenEpi version 3 software to calculate the sample size and power of the study. The OpenEpi software is appropriate to calculate sample size for retrospective cross-sectional studies and other observational and experimental studies.

To calculate the sample size for my study, I selected the cohort or cross-sectional of the OpenEpi statistical calculator. To determine the sample size, I made several assumptions about the study. The assumptions of the study were based on the odd ratio (*OR*) of the outcome variable with association with independent variables, with the *OR* of the unexposed to the exposed and the percentage outcome in the unexposed group as well as the percentage outcome in the exposed group. The percentage outcome in the unexposed group represents the incidence rate of patients in the unexposed group, while the percentage outcome in the exposed group represents the incidence rate of patients in the exposed group. I selected the two-sided confidence level of 95% with the desired power of 80% to detect the group difference at the 95% confidence level. I researched peer-reviewed literature to provide information on the contribution of the key independent variables to the *OR* of the dependent or outcome variable.

From the literature, I selected the *OR* contributed by one of my independent variables on the dependent variable to determine the sample size for my research. Based on the review of the literature, I selected the *OR* that would generate the maximum sample size for my study. The independent variables such as gender, age, exposure to body fluids, contact a living sick person, and contact with dead bodies during funeral rites make available useful information in determining the sample size utilizing the *OR* of the independent variables. Nkangu et al. (2017), documented that gender is a significant factor that contributed to the outbreak of EVD in Liberia, Guinea, and Sierra Leone. Their results showed that female patients had a higher exposure rate than men but the survival rate among female patients was higher than male patients, and the odds of death were much lower for female patients when compared to male patients after adjusting for age with the recorded *OR* of 0.83 at 95% CI: 0.76-0.91. A similar study conducted by the WHO Ebola Response Team (2016) found significant differences in higher survival rates among female patients than male patients who were hospitalized at various Ebola Treatment Units across the country with the OR of 0.83; 95% CI, 0.77 to 0.91.

Age group is well documented as a contributing factor for the outbreak of EVD. Chérif et al. (2017) found that patients of younger age groups in Guinea had a significant high increase of confirmed EVD cases and mortality with the adjusted *OR* of 0.995; 95% CI; $p < 0.05$. Several researchers have established a significant association between the different age groups and the spread and contraction of EVD (Bah et al., 2015; Fitzgerald et al., 2016; Bower et al., 2016; Ji et al., 2016; Qin et al., 2015; Ying-Jie et al., 2016). To further investigate the characteristics of patients who were admitted at Ebola treatment facilities, the International Ebola Response Team et al. (2016) performed multivariable logistic regressions on the risk of being a potential source contact or potential transmitter. The International Ebola Response Team et al. (2016) found that patients who were named as potential funeral contacts were the more severely affected cases of EVD with the *OR* of 1.81.

Table 1

Calculation of Sample Size Using OpenEpi for Cross-Sectional and Cohort Studies

Sample size for cross-sectional studies			
Two-sided significance level(1-alpha):			95
Power (1-beta, % chance of detecting):			80
Ratio of sample size, unexposed/exposed:			5
Percent of unexposed with outcome:			80
Percent of Exposed with Outcome:			88
Odds ratio:			1.8
Risk/Prevalence ratio:			1.1
Risk/Prevalence difference:			7.8

	Kelsey	Fleiss	Fleiss with CC
Sample Size: Exposed	236	218	233
Sample Size: Nonexposed	1176	1088	1164
Total sample size:	1412	1306	1397

Grounded in the literature review, the OR used to calculate the sample size ranged from 0.83 to 5.56. I used the OR of 1.8 to estimate my sample size to generate sufficient power for this research. Also, I used the 95% CI and an 80% power to determine the sample size, since my research hypothesis is a two-sided significance level test. Table 1 provides a summary of the result of the sample size calculation utilizing the OpenEpi model. Table 1 shows that I needed a sample size of 1397 samples for my study from the Fleiss with Continuity Correction method.

Instrumentation and Operationalization of Constructs

This research was based on data collected for public health response activities during the outbreaks of EVD in Liberia. Data were collected during the outbreaks of EVD to help with surveillance and public health response. The instrument of the data collection was individual patient's medical records, and history admitted to Ebola treatment facilities during the outbreaks of EVD in Liberia. Each Ebola treatment facility kept and managed the medical records of patients including each patient's medical history, triage, laboratory test results, and other relevant information on all the patients. Information from EVD cases was collected utilizing a standardized case investigation form and the Epi Info Viral Hemorrhagic Fever Application (NPHIL, 2017). Each Ebola treatment facility collates information on patients and send it to the National case databases and then shared with Ministry of Health, WHO, NIH, CDC, and international organizations working in Liberia (NPHIL, 2017). To gain access to the data, a data use agreement and letter of confidentially or permission to use the data will be obtained and signed by the NPHIL coordinated by the IRB. The letter of permission to use the data will be included in the Appendix section of this study.

Instrumentation

I conducted a quantitative analysis utilizing secondary data collected by Public health and health care professionals during and after the 2014 outbreaks of EVD in Liberia, to determine the risk factors associated with the outbreak of EVD in Liberia with the outcome of interest being patients who were examined for EVD. The design of this study required the utilization of secondary data collected by the Liberia Ministry of Health. During the outbreak of EVD, several public health agencies including the Ministry of Health of Liberia, WHO, the CDC, the NIH, and other international agencies collected data in communities, counties, and Ebola treatment unit for surveillance and public health response purposes. Since the outcome of the study is binary for the EVD dataset, the reliability and validity of this study was performed using Chi-square Cramer’s V correlations statistics. The Chi-square Cramer’s V provided the strength of the relationship between the variables.

Operationalization of Variables

Table 2 shows the variables that was used in this study including the variable names, variables labels, and level of measurement. The independent variables used in this study included age, gender, contact with body fluids, contact with a sick person, funeral attendance, county or community of residence. The outcome or dependent is the contraction of EVD or EVD status.

Table 2

Variables That Were Analyzed in This Doctoral Study

Name of variable	Variable label	Level of measurement
Age	Age of patient	Ordinal
Gender	Gender of Patient	Nominal/Dichotomous
Sick contact	Exposure to contact with a sick person	Nominal/Dichotomous
Body Fluids Exposure	Exposure to contact with body fluids	Nominal/Dichotomous
Funeral Exposure	Funeral attendance and contact with a dead body	Nominal/Dichotomous
County	County of residence	Nominal
EVD status	EVD laboratory test results	Nominal/Dichotomous

Dependent Variable

Contraction of Ebola virus disease (outcome or dependent variable). Based on the secondary data obtained for this study, those who contracted the disease or tested positive for EVD RNA were used as my outcome variable. The outcome variable was dichotomized into PCR Positive for virus and PCR Negative for the virus. The variable was coded as 0 = Negative and 1 = Positive for EVD.

Independent Variables

Age or age groups. Age refers to the years of life at the time when the patients' history was gathered, and laboratory tests were carried out and stored in the database for research purposes. Age was the time between the day the participants were born and the time they were admitted to the Ebola treatment units and diagnosed with EVD. Age groups were indicated by 0 = 1-4 year; 1 = 5-9 years; 2 = 10-14 years; 4 = 15-19 years; 5 = 20-24 years; 6 = 25-29 years; 7 = 30-34 years; and 8 = 35-39 years; 9 = 40-44; 10 = 45-49; 11 = 50-54; 12 = 55-59; 13 = 60-64; and 14 = >65 years. Age was measured as a categorical variable.

Gender. Gender was indicated by 0 = male and 1 = female in the study. Gender was recorded as a categorical or dichotomous variable.

Community or county of residence. Community or county or residence was the location where the disease was contracted or transmitted either by direct or indirect contact with body fluids, participating in funeral rites, washing dead bodies, or some other means.

Contact with body fluids. a person who took unprotected care of suspected or probable case-patient with unexplained bleeding, vomiting, diarrheal disease, body waste or stool, and more. Contact with body fluid was recorded as a dichotomous variable, where 1 = Yes (contact with body fluids) and 0 = No (no contact with body fluids).

Funeral exposure. Funeral exposure occurs with touching of the dead and attendance at a funeral. Funeral attendance was recorded as a dichotomous variable, where 1 = Yes (attended funeral) and 0 = No (did not attend funeral).

Contact with the sick. Contact occurs when a person who came in close proximity with a suspected or confirmed case patient. Contact with a living sick person was recorded as a dichotomous variable, where 1 = Yes (contact with a living sick person) and 0 = No (no contact with a living sick person).

Data Analysis Plan

A descriptive and inferential statistics will be performed using the Statistical Program for the Social Science (SPSS) version 25 to describe the dataset and analyze or examine whether there was association between the outcome or dependent variable of EVD contraction or status and the independent variables of age, gender, funeral attendance, contact with body fluids, contact with a living sick person, and community or county of residence. IBM SPSS statistical software will provide meaningful insights from the dataset and predicts the statistical significance of the variables and improves the efficiency of the study. Also, SPSS has the capability to conduct both inferential and descriptive statistics utilizing all the statistical tests necessary to address the research questions. The descriptive statistics included frequency and percent distributions.

Research Questions and Hypotheses

The following research questions were used and addressed in this quantitative study to investigate the risk factors associated with the 2014 outbreak of EVD in Liberia:

RQ1: What is the relationship between the contraction of EVD and individuals' age group and gender?

$H_0$1a: There is no association between individuals' age group and the contraction of EVD.

H_A1a: There is a statistically significant association between individuals' age group and the contraction of EVD.

$H_0$1b: There is no association between individuals' gender and the contraction of EVD.

H_A1b: There is a statistically significant association between individuals' gender and the contraction of EVD.

RQ2: What is the relationship between individuals' counties of residence and the contraction of EVD?

$H_0$2: There is no association between individuals' counties of residence and the contraction of EVD.

H_A2: There is an association between individuals' counties of residence and the contraction of EVD.

RQ3: What is the relationship between funeral attendance and contraction of EVD?

$H_0$3: There is no association between funeral attendance and the contraction of EVD.

H_A3: There is an association between funeral attendance and the contraction of EVD

RQ4: What is the relationship between exposure to body fluids and contact with a living sick person and the contraction of EVD?

$H_0$4a: There is no association between the exposure to body fluids and the contraction of EVD.

H_A4a: There is an association between the exposure to body fluid and the contraction of EVD.

$H_0$4b: There is no association between the contact with a living sick person and the contraction of EVD.

H_A4b: There is an association between the contact with a living sick person and the contraction of EVD.

Statistical Tests for the Study Outcome

To address each research question (RQ1, RQ2, RQ3, and RQ4), Pearson's Chi-square test with cross-tabulation was used to test the relationship or association between the independent variables (age, gender, funeral attendance, contact with body fluids, contact with a living sick person, and community or county of residence) and the outcome variable (EVD status or contraction). The Pearson's Chi-square test of association or independence is a nonparametric test was used to determine whether a significant relationship exists between two or more of categorical nominal variables in the dataset (Green & Salking, 2008). The Chi-square test utilizes a cross-tabulation or two-way table to analyze the categorical data. The Phi and Cramer's V correlation was used to test the strength of the relationship between the dependent and independent variables.

Logistic regression was used to test the predictive influence of the dependent and independent variables. Multiple logistic regressions were used to analyze or examine the strength of each variable since the independent, and the dependent variables are categorized as categorical variables (Green & Salking, 2008). Multiple logistic regressions analysis is a statistical technique used for predicting the value of a variable based on the value of two or more variables known as the predictors (Green and & Salking, 2008). Multiple logistic regression is an extension of a binary logistic regression. Multiple logistic regression analysis explains the relationship or correlation between a dependent variable or a single dichotomous outcome and more than one independent variable (Green & Salking, 2008).

All statistical tests in this research were performed at a 5% (0.05) significance level with the estimate of effects calculated at the 95% CI, the *OR*, and a *p*-value of less than or equal to 0.05. All independent variables that will show a significant contribution to the dependent or outcome variable will be modeled into logistic regressions. By identifying the predictor variables that have the most effect on the contraction and spread of EVD will assist healthcare workers and public health professionals who are more likely to be vulnerable to contracting and spreading EVD in any future outbreaks in Liberia.

Threats to Validity

The principles of validity and reliability are the fundamental pillars of research method and analysis (Creswell, 2009). The validity of a quantitative research study refers to whether one can draw useful and meaningful inferences from scores on instruments (Creswell, 2009). Establishing the validity of this study helped to identify whether the study instrument might be a good one to use in the study. According to Creswell (2009), there are three traditional forms of validity to look for when conducting the research study: (a) content validity—do the items measure the content they intended to measure?

(b) Predictive or concurrent validity—does the study results correlate with other results? (c) Construct validity—does the scores in the study served a useful purpose and positive consequences when they were used in the study. One of the key problems for researcher, in a research study, is the ability to show that the variable of interest or the outcome variable is not influenced by some outside forces or some other factor other than a team of investigators that the researcher set up to investigate—which can generate and lead to a threat to validity. Therefore, it is critical for a researcher to identify threats to validity and find ways to mitigate the effects of the threats of validity. According to Creswell (2009), there are two types of threats to validity: (a) internal threats validity and (b) external threats validity

Internal Threats to Validity

Internal threats to validity must be established before the study results can be generalized to the populations beyond the subjects of the study (Aschengrau & Seage, 2014). After the measure of association has been determined, the researcher must evaluate whether the observed result of the study is true—the researcher must assess the internal validity of the results of the study (Aschengrau & Seage, 2014). To make sure that the results of my study are valid, I eliminated systematic bias and random error. According to Aschengrau and Seage (2014), systematic bias or error in the study design can lead to an erroneous relationship between the independent (exposure) and outcome (disease) variable. Controlling for any potential confounding variables will provide more confidence that the contraction or transmission of EVD is due to the independent variables. If systematic bias, random error, and confounding are rule out of the study, one can conclude that the relationship between the variables is true and the study will have internal validity (Aschengrau & Seage, 2014).

External Threats to Validity

Threats to external validity arise when researchers draw improper or incorrect inferences from the sample data to other persons, settings, and past or future conditions (Creswell, 2009). The threats to external validity also arise when the researchers generalize beyond the groups in the study to other groups that are not involved in the study and to setting not studied. The characteristics of the participants selected for the sample, the uniqueness of the research setting, and the timing of the study will give rise to the external threats of the study (Creswell, 2009). Threats to external validity can be any factors within the study that minimize or reduce the generalizability of the overall results of the study (Aschengrau & Seage, 2014). The evaluation of external validity requires review of the study design or methods and the biological makeup of the study subject or population (Aschengrau & Seage, 2014).

Selection biases are one of the most significant threats to external validity (Aschengrau & Seage, 2014). Selection bias results from measures that are used to select the study subjects that provide a result among the study participants different from the result that would take place among all eligible participants in the study population (Aschengrau & Seage, 2014). The selection of the study population and locations can be a possible source of bias—that may likely introduce threats to external validity. Since the subjects or participants of this study were selected from Ebola treatment facilities in Liberia, there might be a possibility of generalizing the conclusions of the study outcome to the general EVD population. The selection of the different Ebola treatment facilities was made with the intent to include each geographical location to be represented in the study.

Ethical Procedures

There are several ethical issues that must be considered when designing or planning any type or kind of research study. The collection of data for research study costs money and time to collect, analyze, interpret, and disseminate data and results (Aschengrau & Seage, 2014). It is important to recognize and address ethical issues at all stages of the research studies. Ethical issues in research studies may result from interviews, questionnaires, the methods used in data collection, the kind of information sought after, and voluntary participation and informed consent (Creswell, 2009). Secondary data can be analyzed to generate new hypotheses and answer key research questions (Tripathy, 2013). The analysis of secondary dataset saves time, money, and other resources (Tripathy, 2013). However, some ethical procedures and issues must be followed when working with secondary data.

The secondary data for this study was performed or collected as part of the public health response to the 2014 outbreaks of EVD in Liberia. In accordance with the United States federal human subject's protection regulations and the CDC's guidelines for defining public health research and public health non-research, the data collected on patients is not considered to be human subjects research (Fallah et al., 2015). This research study utilizes de-identified secondary data from the 2014 EVD outbreaks in Liberia. The dataset does not include the name or identity of the participants. Despite the de-identification of the dataset, the data use agreement must be adhered to by safeguarding and not disclosing or discussing any confidential information with others, including friends or family member.

During my activity utilizing this secondary data, I will have access to de-identified patients' information that is confidential and will not be disclosed or shared with others. I will uphold the highest virtue of academic integrity by respecting individual privacy at all levels of the study and acknowledge that the improper disclosure of confidential information can be detrimental to the participants. I will make sure not to allow any unauthorized transmissions, inquires, modification or purging to the confidential information in the dataset. I agreed with NPHIL that violation of the data confidentially agreement would have legal implications. A letter of authorization is included in Appendix A based on an approval from the IRB at Walden University (Walden IRB approval no. 01-11-19-0384550).

The IRB is responsible for making sure that all researchers act in agreement with the ethical standards of research on human subjects as well as the federal regulations (Walden University, 2017). Protecting the safety of the participants in research studies is a high priority for researchers or investigators. The IRB is an independent committee formed by institutions or organizations that sponsor research studies (Walden University, 2017). The IRB was able to review the research proposal for compliance with all ethical protocols relating to the study participants. The IRB granted me the approval to use this dataset.

Summary

The primary purpose of this quantitative research was to investigate potential factors that are associated with the outbreak of EVD contraction in Liberia. I employed a cross-sectional retrospective quantitative design—utilizing secondary data from the 2014 outbreaks of EVD in Liberia. In this section (section 2), I discussed and provided detail information about the research method and design that was used in conducting this study. A detailed description of the study methodology included a description of the target population, the study participants, and the sampling procedures used to obtain the data were discussed. I also discussed and justified the sampling strategy used in the study including the inclusion and exclusion criteria of the sampling framework.

The operationalization for each of the variable was defined and discussed, and their levels of measurement were defined. The research questions and hypotheses were restated, and the statistical methods that will be used to address the research questions were thoroughly discussed. The statistical software used to analyze the data was identified. The threats to validity, both external and internal threats to validity, were discussed and how their effect on the outcome of the study can be alleviated or mitigated. The ethical procedures and the agreements to gain access to the secondary data were elucidated. All the steps that are necessary to maintain patients confidentially were deliberated including permissions from the IRB that will allow me to use the secondary dataset on the 2014 outbreak of EVD in Liberia. In the next section (Section 3), the results and findings of the study will be discussed and presented, in connection with the research questions.

Section 3: Presentation of the Results and Findings

Introduction

The primary purpose of this quantitative research was to examine risk factors that are associated with the contraction of EVD in Liberia. Knowing and understanding factors that are associated with the contraction and spread of the disease is critical–, prompting the need for this research study. Identifying the risk factors of EVD contraction could help guide public health interventions and target public health resources during an outbreak of EVD. In this study, I used a retrospective cross-sectional design by analyzing secondary data collected on patients admitted to Ebola treatment units in Liberia.

In Section 1, I provided a review of current literature on key variables of this study including the geographical location and population of Liberia, the epidemiology of the outbreak of EVD in Liberia, factors associated with the contraction of EVD including age, gender, county of residence, funeral attendance, exposure to body fluids; and close contact with living sick persons. In Section 2, I discussed the research design in connection with the research questions and rationale including the study variables (dependent and independent variables). I also discussed the methodology used in this research including components such as the target population, sampling and sampling procedures employed to collect the data, instrumentation, and operationalization of the variables, ethical procedures, and the threats to validity and how they can be adhered to in this research.

Utilizing SPSS version 25, I put forth the following research questions and hypotheses, and addressed them in this quantitative study using Chi-square test for association and Logistic Regression to analyze the dataset:

RQ1: What is the relationship between the contraction of EVD and individuals' age group and gender?

$H_0$1a: There is no association between individuals' age group and the contraction of EVD.

H_A1a: There is a statistically significant association between individuals' age group and the contraction of EVD.

$H_0$1b: There is no association between individuals' gender and the contraction of EVD.

H_A1b: There is a statistically significant association between individuals' gender and the contraction of EVD.

RQ2: What is the relationship between individuals' county of residence and the contraction of EVD?

$H_0$2: There is no association between individuals' county of residence and the contraction of EVD.

H_A2: There is an association between individuals' county of residence and the contraction of EVD.

RQ3: What is the relationship between funeral attendance and contraction of EVD?

$H_0$3: There is no association between funeral attendance and the contraction of EVD.

H_A3: There is an association between funeral attendance and the contraction of EVD

RQ4: What is the relationship between exposure to body fluids and contact with a living sick person and contraction of EVD?

$H_0$4a: There is no association between the exposure to body fluids and the contraction of EVD.

H_A4a: There is an association between the exposure to body fluid and the contraction of EVD.

$H_0$4b: There is no association between the contact with a living sick person and the contraction of EVD.

H_A4b: There is an association between the contact with a living sick person and the contraction of EVD.

I discuss the data collection and preparation process in this section. This section contains my analysis of the data obtained from the NPHIL on the 2014 outbreak of EVD in Liberia. In this section, I present the results of the secondary data analysis. I provide the general descriptive statistics that appropriately characterize the samples. I report the statistical analysis findings, organized by the research questions and hypotheses testing, including the Chi-square test for the association for RQ1, RQ2, RQ3, and RQ4, and logistic regression analysis for RQ1, RQ3, and RQ4. I report the results from the statistical analysis tests in a manner consistent with the research questions and hypotheses.

Data Collection of Secondary Data Set

For this research study, I used a retrospective cross-sectional design to analyze secondary data collected during the 2014 to 2015 EVD outbreaks on patients admitted to various Ebola treatment facilities in Liberia. The data is secondary data obtained from Ebola treatment units by public health and health care professionals during and after the outbreak of EVD in Liberia in 2014. The instrument of the data collection was individual medical records and history of patients admitted to Ebola treatment facilities during the outbreaks of EVD in Liberia. Each Ebola treatment facility kept and managed the medical records of patients including each patient's medical history, triage, laboratory test results, and other relevant information on all the patients. Each Ebola treatment facility collates information on patients and sends it to the national case databases, which are shared with Ministry of Health, WHO, NIH, CDC, and international organizations working in Liberia (NPHIL, 2017). To gain access to the data, a data use agreement and letter of confidentially and permission to use the data was obtained and signed by the NPHIL coordinator and reviewed by the IRB. The letter of permission to use the data is included in Appendix A.

Time Frame for Data Collection and Discrepancies of the Secondary Dataset

The data collection occurred from 2014 to 2015 during the outbreak of EVD on patients admitted to various Ebola treatment units in Liberia. The data included deidentified patients' ID number, county of report, Ebola treatment unit, age, gender, history of contact with sick individuals, exposure to body fluids, funeral attendance and burial rituals, county or community of residence, and EVD status (laboratory findings). The deidentified dataset contained a total of 1,658 samples (*n* = 1,658) analyzed in this study. To ensure the quality and address discrepancies in the secondary data, the dataset was analyzed using the IBM SPSS Statistic 25. SPSS was used to analyze the data, check for missing data in the dataset, and more. To control for the missing values in the dataset, I performed a transformation of the variables by automatically recoding the variables in SPSS and treating the blank string values as user-missing. Utilizing an appropriate technique to handle cases with missing data when performing secondary analyses is crucial to reducing biases, avoiding inaccurate results, and not reaching an invalid conclusion (Langkamp, Lehman, & Lemeshow, 2010). Missing data can be defined as the data value that is not accounted for and stored for a variable of interest in the observation of the dataset (Kang, 2013). Missing data occurs in nearly all research studies, even well-designed studies (Kang, 2013). If the missing values in the dataset are not accounted for by the researcher, the researcher may report out or conclude an inaccurate finding of the study (Kang, 2013).

Not all cases of EVD were recorded and reported in the secondary dataset provided by the NPHIL. The data in this study were either self-reported or reported by family members or friends or inferred by the interviewers and may contain biases. For instance, some of the patients may recall the exposure to body fluids or funeral rituals in more detail or have different takes of what constitutes exposure to body fluids and contact with suspected case-patients. The sample size was adequate and above the minimum sample determined in the power analysis in Section 2.

Baseline Descriptive and Demographic Characteristics of the Sample

The target population in this study comprised a cross-section of patients, all ages, both males and females, admitted to Ebola treatment units during the 2014 outbreak of EVD in Liberia. Liberia is a relatively dense nation, located on the west coast of Africa and bordered by Guinea, Ivory Coast, and Sierra Leone (WHO, 2016). Liberia is one of the smallest and lowest-income nations in Sub-Saharan Africa with a population of more than 4.6 million people (WHO, 2016). According to the WHO (2016), more than half of the population in Liberia lives in the urban areas, with one-third of the total population residing within 40 to 50 miles of Monrovia, the capital city of Liberia. This study was based on secondary data recorded during the EVD crisis from patients admitted at Ebola treatment centers in Liberia without any opportunity for primary data collecting and analysis. Therefore, only variables that are in this data were analyzed. In this study, I included data only on the EVD outbreaks among a cross-section of patients who were enrolled and admitted to Ebola treatment units between the years 2014 to 2015.

A total of 1,658 samples (n = 1,658) were analyzed in this study. Even though over 10,604 cases were recorded and reported by Ebola treatment units in Liberia, the NPHIL provided a random sample of 1,658 cases analyzed for this study. To quantify the risk factors for the contraction of EVD, I performed descriptive analyses, analyzing secondary data collected by the Liberia Ministry of Health during the outbreak in Liberia. From the sample, a total of 1,658 samples were analyzed using laboratory findings for patients tested for the detection of EVD RNA by RT-PCR or IgM antibodies against EVD (Coltart et al., 2017; Furuse et al., 2017). People who were tested positive for the virus with RT-PCR test specific for EVD were labeled as confirmed cases of EVD. A descriptive characteristic of the sample population included the patients' gender, age category, whether the patient was exposed to people who were sick with the virus, exposure to body fluids, whether the patient attended funeral arrangements, the patients' county of residence, and each patient's EVD status. The sample size in the analysis was adequate and above the minimum sample determined in the power analysis in Section 2.

Results of the Study

Summary Descriptive Statistics that Characterize the Sample

The sample consisted of 1,658 participants. Table 3 shows the frequencies and percentages of the characteristic of the patients sampled in the study. The results indicated that among the 1,658 cases, 45.1% (747) of the study participants were female, and 54.9% (910) were male. Figure 2 illustrates the distribution of gender among male and female. The results also indicated that among the 1,658 cases, 4.8% (80) fell within the age group of 0-4 years; 4.2% (70) within 5-9 years; 5.1% (84) within the age group of 10-14 years; 7.7% (127) within 15-19 years; 9.5% (157) within 20-24 years; 13.0% (216) within 25-29 years; 9.4% (156) within 30-34 years; 11.0% (182) within 35-39 years; 9.5% (157) within the age group of 40-44 years; 7.4% (123) within 45-49 years; 6.0% (100) within 50-54 years; 3.2% (53) within 55-59 years; 2.6% (43) within the age group of 60-64 years; and 3.4% (56) within the age group of 65 years and older. The mean age of the study population was 32.4 years ranging from 0 to 89 years and an *SD* of 16.67 years.

Table 3 also shows that 8.9% (148) of the patients indicated they attended funeral arrangement and 50% (843) that they did not attend funeral rites. About 33.2% (550) of the participants did not encounter a living sick person, and 28.7% (476) indicated that they were in close contact with a living sick person. Approximately 20.1% (334) indicated an exposure to human body fluids while 38.8% (644) did not encounter human body fluids exposure. Ninety-three percent (1,544) of the participants resided in Montserrado County; 0.8% (14) resided in Bomi County; 1.4% (24) resided in Bong County; 0.1% (2) resided in Grand Bassa County; 0.3% (5) resided in Grand Cape Mount County; 0.2% (3) resided in Lofa County; and 2.3% (38) of the participants resided in Margibi County. A total of 46.0% (763) of the patients were tested positive for EVD, while 54.0% (895) of the patients were negative for EVD as depicted in Table 3 and Figure 3.

Table 3

Descriptive Statistics of Patient Characteristics

Patient characteristics	Frequency	Percent (%)
Gender		
Female	747	45.1
Male	911	54.9
Total	1658	100.0
Age category		
0-4	80	4.8
5-9	70	4.2
10-14	84	5.1
15-19	127	7.7
20-24	157	9.5
25-29	216	13.0
30-34	156	9.4
35-39	182	11.0
40-44	157	9.5
45-49	123	7.4
50-54	100	6.0
55-59	53	3.2
60-64	43	2.6
65 and older	56	3.4
Missing	54	3.3
Total	1658	100.0

Patient characteristics	Frequency	Percent (%)
Exposed to sick contact		
Missing	632	38.1
No	550	33.2
Yes	476	28.7
Total	1658	100.0
Body fluids exposure		
Missing	680	41.0
No	644	38.8
Yes	334	20.1
Total	1658	100.0
Funeral attendance		
Missing	667	40.2
No	843	50.8
Yes	148	8.9
Total	1658	100.0

(table continues)

Patient characteristics	Frequency	Percent (%)
County of residence		
Bomi	14	
Bong	24	1.4
Grand Bassa	2	.1
Grand Cape Mount	5	.3
Lofa	3	.2
Margibi	38	2.3
Montserrado	1544	93.1
Total	1658	100.0
EVD_status		
Negative	895	54.0
Positive	763	46.0
Total	1658	100.0

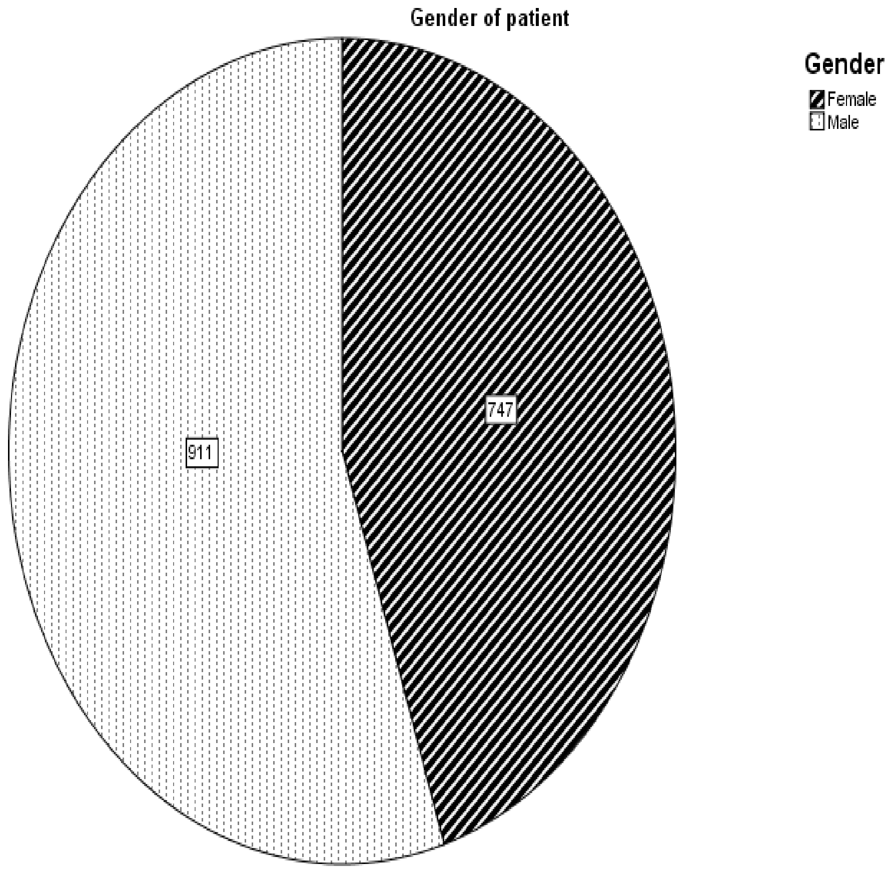

Figure 2. Gender of patients.

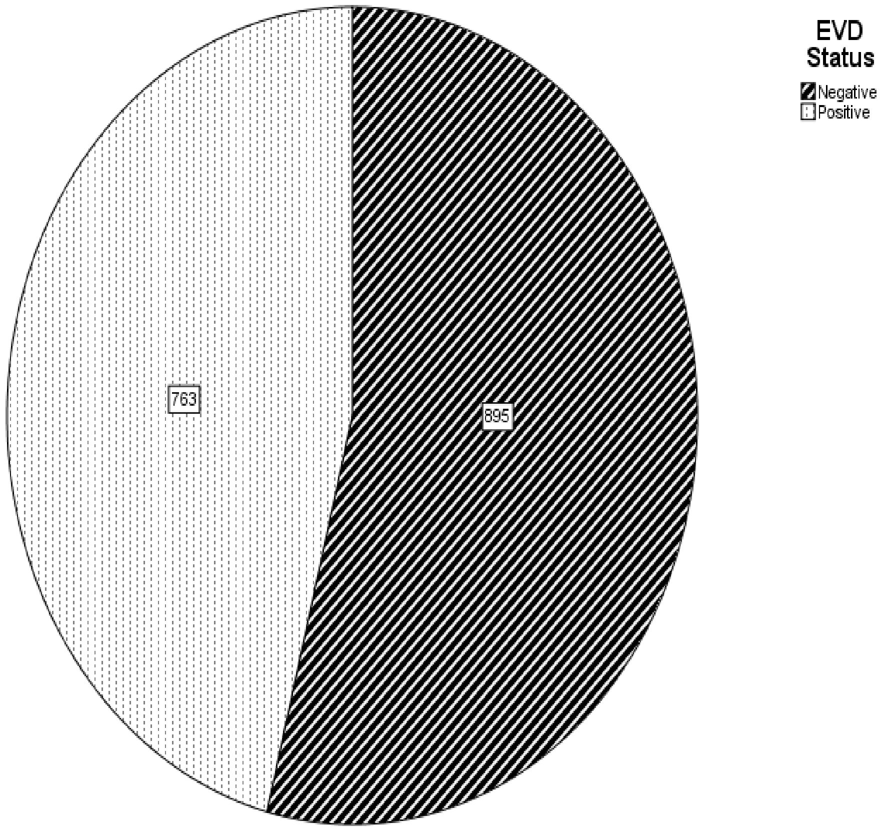

Figure 3. EVD status of patients.

Statistical Analysis Assumptions

I utilized two statistical analysis tests (Pearson's Chi-square test and logistic Regression analysis) to address the four research questions in this research study. Pearson's Chi-Square test for association was used as the primary statistical test to test whether there is an association between each variable in RQ1, RQ2, RQ3, and RQ4. The Chi-square test of association is a nonparametric test used to determine whether a relationship exists between two or more categorical nominal variables in a dataset (Frankfort-Nachmias & Leon-Guerrero, 2015). The Chi-square test utilizes a cross-tabulation or two-way table to analyze the categorical data. The Phi and Cramer's V correlation was used to test the strength of the relationship between the dependent and independent variables.

The assumptions of Pearson's Chi-square test are the data in the cells to be frequencies or counts of the cases than percentages or some change or transformation of the data (McHugh, 2013). Another assumption of the Chi-square test is the categories of the variables must be mutually exclusive (McHugh, 2013). Also, the study groups must be independent—which means that two variables must consist of two or more categorical or independent groups (McHugh, 2013). The variables used in this study are categorical variables (nominal or ordinal level), and the value of the cells expected are five and above. The assumptions for the Chi-square test were met because the study groups are independent, mutually exclusive, nominal or ordinal categories, and the sample size had cell count with five or more than five.

Logistic Regression was used to determine and test the independent variables (Age, gender, funeral attendance, exposure to body fluids, and exposure to sick contact) have any predictive influence on the dependent variable (contraction of EVD). I analyzed RQ1, RQ3, and RQ4 utilizing binary logistic regression to determine whether the independent variables had any predictive influence on the dependent variable. According to Hosmer and Lemeshow (2000), the assumptions based on the logistic regression analysis must be: (a) a dichotomous or ordinal dependent variable; (b) the dependent variables should have mutually exclusive and exhaustive categories; (c) the factor of one is the desired outcome; and (d) the data must contain a large sample size. Based on the assumptions of the logistic regression analysis, all the rules were met for this analysis.

Statistical Analysis Findings Organized by Research Questions

A Chi-square test for association was conducted to address RQ1, RQ2, RQ3, and RQ4 in this research study. Chi-square test for association was used as the primary statistical test to assess whether there was an association between the research variables in each of the research question. On the other hand, Logistic Regression was used to analyze the predictive influence of the independent variables (age, gender, and funeral attendance, exposure to body fluids, and contact with a living sick person) on the dependent variable (contraction of EVD). This subsection includes the statistical analysis findings organized by the research questions (RQ1, RQ2, RQ3, and RQ4) and the research hypotheses.

Chi-Square Test for Association

RQ1: What is the relationship between the contraction of EVD and individuals' age group and gender?

$H_0$1a: There is no association between individuals' age group and the contraction of EVD.

H_A1a: There is a statistically significant association between individuals' age group and the contraction of EVD.

Using the sample size of $n = 1{,}604$, a Chi-square test for association was conducted to assess whether individuals' age group is associated with the contraction of EVD. The two variables were the age of the participants with 14 levels and the contraction of EVD with two levels (positive and negative). The result in Table 4 shows statistically significant association between the patients' age and EVD contraction, X^2 (83) = 122.02, $p < 0.05$, Cramer's V = 0.28. Therefore, the null hypothesis can be rejected that there is no statistically significant association between the age groups and the contraction of EVD. The observed difference is statistically significant, and there is evidence to reject the null hypothesis. Cramer's V correlation in Table 4 also provides the strength of the relationship. A value of 0 indicates no association or difference, and a value of 1.0 indicates a very strong or perfect association. Cramer's V correlation shows a small or weak association between the variables. A binary logistic regression was conducted to further examine the influence of the patients' age on the contraction of EVD. See results in the logistic regression analysis section of this study.

Table 4

Chi-Square Results for Age Group and Ebola Virus Disease Status

	Value	df	*p*-value
Pearson Chi-square (X^2)	122.02[a]	83	0.003
Likelihood ratio	138.45	83	0.000
Cramer's V	0.28		0.003
N of valid cases	1604		

$H_0$1b: There is no association between individuals' gender and the contraction of EVD.

H_A1b: There is a statistically significant association between individuals' gender and the contraction of EVD.

Applying the sample size n = 1658, a Chi-square test for association was conducted to assess whether the participants' gender was associated with the contraction of EVD in Liberia. The two variables were the gender of the patients with two levels (male and female) and the contraction of EVD with two levels (positive and negative). With the expected count values shown in Figure 4, all the cells have an expected value of greater than five. The result in Table 5 shows no statistically significant association between the patients' gender and EVD contraction, X^2 (1) = 1.86, $p = 0.173$, Cramer's V = 0.034. Therefore, the null hypothesis cannot be rejected that there is no association between the patients' gender and the contraction of EVD. Cramer's V correlation shows a very weak or no association between the variables.

Table 5

Chi-Square Results for Gender and Ebola Virus Disease Status

	Value	df	*p*-value
Pearson Chi-square (X^2)	1.861a	1	0.173
Likelihood ratio	1.860	1	0.173
Cramer's V	0.034		0.173
N of valid cases	1658		

Figure 4 and the crosstabulation Chi-square in Table 6 show that 52.1% (390 out of 748) female tested negative for EVD; 47.9% (358 out of 748) tested positive for EVD; 55.5% (505 out of 910) male tested negative for EVD; and 44.5% (405 out of 910) tested positive for EVD. The results from the Chi-square test for association as shown in Table 5&6 and Figure 4 support the *null* hypothesis that is no statistically significant association between the patients' gender and the contraction of EVD. Therefore, the null hypothesis cannot be rejected. Given that these results are different from most research findings, a binary logistic regression was conducted to further examine the influence of gender on the contraction of EVD. See results in the logistic regression analysis section of this study.

Table 6

Chi-Square Results Crosstabulation for the Contraction of Ebola Virus Disease and Gender

Gender and EVD status crosstabulation

			EVD status		
			Negative	Positive	Total
Gender	Female	Count	390	358	748
		Expected count	403.8	344.2	748.0
		% within gender	52.1%	47.9%	100.0%
	Male	Count	505	405	910
		Expected count	491.2	418.8	910.0
		% within gender	55.5%	44.5%	100.0%
Total		Count	895	763	1658
		Expected count	895.0	763.0	1658.0
		% within gender	54.0%	46.0%	100.0%

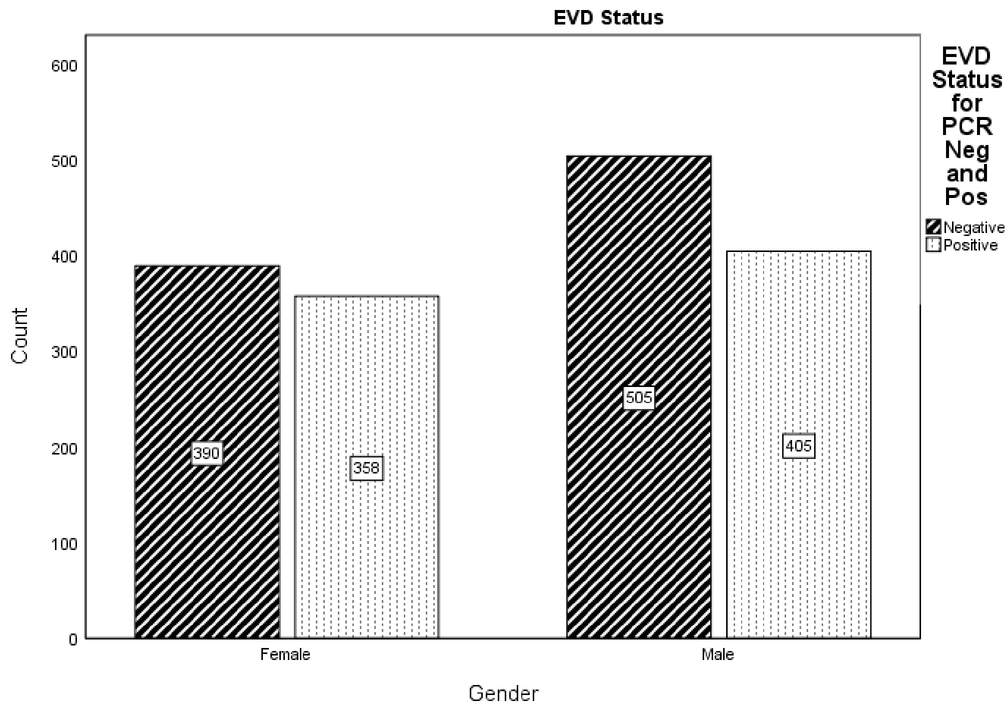

Figure 4. Chi-square results for gender and Ebola virus disease.

RQ2: What is the relationship between individuals' county of residence and the contraction of EVD?

$H_0$2: There is no association between individuals' county of residence and the contraction of EVD.

H_A2: There is an association between individuals' county of residence and the contraction of EVD.

In Table 7, I conducted a Chi-square Fisher's Exact test to examine the relationship between the patients' county of residence and EVD. Fisher's Exact test is used or applied in the analysis of small samples (Kim, 2017). Fisher's Exact test is one of the exact tests that is utilized when more than 20% of the cells counts have expected values or frequencies less than five (Kim, 2017). In this case, the expected cell frequencies were less than five. Table 8 (Crosstabulation table) shows that more than 20% of the expected cell frequencies were less than five. The results showed no statistically significant association between the patients' county of residence and the contraction of EVD, X^2 (7) = 9.63, Fisher's Exact test = 9.46, *p* = 0.21, and Cramer's V = 0.077. Cramer's V analysis shows a very weak association between the patients' county of residence and the contraction of EVD. The results as shown in Table 8 supports the *null* hypothesis cannot be rejected that there is no association between the patients' county of residence and the contraction of EVD. As a result, we will fail to reject the null that there is no association between the patients' county of residence and the contraction of EVD.

Table 7

Chi-Square and Fisher's Exact Test Results for Ebola Virus Disease and County of Residence

	Value	df	*p-value*	Exact sig. (2-sided)
Pearson Chi-square	9.63[a]	7	0.211	0.184
Likelihood ratio	11.51	7	0.118	0.181
Fisher's exact test	9.46			0.166
Cramer's V	0.077		0.211	
N of valid cases	1631			

Table 8

Chi-Square Results Crosstabulation for the Contraction of Ebola Virus Disease and County of Residence

County of residence * EVD status for PCR neg and pos crosstabulation

		EVD status		
		Negative	Positive	Total
County of residence	Bomi	12	2	14
	Bong	14	10	24
	Grand Bassa	0	2	2
	Grand Cape Mount	3	2	5
	Lofa	2	1	3
	Margibi	21	17	38
	Montserrado	833	711	1544
	Nimba	0	1	1
Total		895	763	1658

RQ3: What is the relationship between funeral attendance and the contraction of EVD?

$H_0$3: There is no association between funeral attendance and the contraction of EVD.

H_A3: There is an association between funeral attendance and the contraction of EVD.

Utilizing the sample size valid cases $n = 991$, a Chi-square test for association was conducted to assess the association between funeral attendance and EVD contraction. The two variables were funeral attendance with two levels (Yes and No) and the contraction of EVD with two levels (positive and negative). Table 10 (Chi-square crosstabulation table) shows that 73.6% of the patients that participated in funeral rites tested positive for EVD, while 26.4% of the patients tested negative for EVD. Thirty-nine percent of the patients that did not attend funeral rites tested positive for EVD, while 61% tested negative for EVD. The result in Table 9 shows statistically significant association between patients that attended funeral rites and EVD contraction, X^2 (1) = 61.64, $p < 0.05$, Cramer's V = 0.25. As a result, the null hypothesis can be rejected that there is no statistically significant association between funeral attendance and the contraction of EVD. The observed difference is statistically significant, and there is evidence to reject the null hypothesis. Cramer's V correlation in Table 9 also provides the strength of the relationship. Cramer's V correlation shows a small or weak effect between the variables. The results as shown in Table 9 supports the alternative hypothesis that there is an association between funeral attendance and the contraction of EVD.

Table 9

Chi-Square Results for Ebola Virus Disease and Funeral Attendance

	Value	df	*p-value*
Pearson Chi-square (X^2)	61.64[a]	1	0.000
Likelihood ratio	62.45	1	0.000
Cramer's V	0.25		0.000
N of valid cases	991		

Table 10

Chi-Square Results Crosstabulation for the Contraction of Ebola Virus Disease and Funeral Attendance

Funeral attendance * EVD status for PCR neg and pos crosstabulation

			EVD status		
			Negative	Positive	Total
Funeral attendance		Count	341	326	667
		% within funeral attendance	51.1%	48.9%	100.0%
	No	Count	515	328	843
		% within funeral attendance	61.1%	38.9%	100.0%
	Yes	Count	39	109	148
		% within funeral attendance	26.4%	73.6%	100.0%
Total		Count	554	437	991
		% within funeral attendance	54.0%	46.0%	100.0%

RQ4: What is the relationship between exposure to body fluids and contact with a living sick person versus the contraction of EVD?

$H_0$4a: There is no association between the exposure to body fluids and the contraction of EVD.

H_A4a: There is an association between the exposure to body fluid and the contraction of EVD.

Table 11 shows the results of the Chi-square test for association performed to test whether there is an association between patients' exposure to body fluids contact and the contraction of EVD. The results of the Chi-square test in Table 11 show a statistically significant association between the exposure to body fluids contact and the contraction of EVD, X^2 (1) = 292.48, $p < 0.05$, Cramer's V = 0.55. Therefore, the null hypothesis of no association between the exposure to body fluids and EVD contraction can be rejected in favor of the alternative hypothesis of the existence of a significant association. Cramer's V correlation in Table 11 also provides the strength of the relationship. Cramer's V correlation shows a moderate effect between the variables. The results support the alternative hypothesis that there is an association between body fluids exposure and the contraction of EVD.

Table 11

Chi-Square Results for Ebola Virus Disease and Exposure to Body Fluids

	Value	df	*p*-value
Pearson Chi-square (X^2)	292.48[a]	1	0.000
Likelihood ratio	308.02	1	0.000
Cramer's V	0.55		0.000
N of valid cases	979		

$H_0$4b: There is no association between the contact with a living sick person and the contraction of EVD.

H_A4b: There is an association between the contact with a living sick person and the contraction of EVD.

The results of the Chi-square test in Table 12 show a statistically significant association between contact with a living sick person and the contraction of EVD, X^2 () = 351.06, $p < 0.05$, Cramer's V = 0.59. As a result, the null hypothesis of no association between contact with a living sick person and EVD contraction can be rejected in favor of the alternative hypothesis of the existence of significant association. The Cramer's V correlation shows a moderate effect between contact with a living sick person and the contraction of EVD. The results support the alternative hypothesis that there is an association between contact with a living sick person and the contraction of EVD. Logistic regression was performed to further examine the association between the patients' contact with a living sick person and the contraction of EVD.

Table 12

Chi-Square Results for Ebola Virus Disease and Exposed to Sick Contact

	Value	df	*p*-value
Pearson Chi-square (X^2)	351.06[a]	1	0.000
Likelihood ratio	373.31	1	0.000
Phi Cramer's V	0.59		0.000
N of valid cases	1027		

Logistic Regression Analysis Results

Logistic regression was employed to examine the influence of age, gender, funeral attendance, exposure to body fluids, and contact with a living sick person on the contraction of EVD. I analyzed age, gender, funeral attendance, exposure to body fluids, and contact with a living sick person utilizing binary logistic regression to determine whether the independent or predictor variables had any predictive influence on the dependent variable (EVD contraction). The logistic regression model is a good fit model for this study, due to its ability to examine the relationship between the variables while adjusting for other variables in the study

The result from the Chi-square test for association showed a significant association between age and EVD contraction without controlling for other variables. A binary logistic regression analysis was performed to examine the association between age and the contraction of EVD while controlling for other variables including gender, funeral attendance, exposure to body fluids, and contact with a living sick person. The results from Table 13 shows that age does significantly predict the odds of contracting EVD among the patients, *OR* = 1.01, 95% Confidence Interval (C.I) [1.00-1.02], $p = 0.06$ and the Wald = 3.67. The result shows that the difference in age is not associated with the contraction of EVD. As a result, we will reject the alternative hypothesis of statistically significant difference between age and EVD contraction and accept the null hypothesis of no statistically significant association between age and the contraction of EVD. Although the Chi-square test of association result indicated a statistically significant association between age and the contraction of EVD, the logistic regression model shows that there is no significant association between age and EVD contraction when adjusting for variables such as gender, funeral attendance, exposure to body fluids, and contact with a living sick person.

The result from the logistic regression analysis in Table 13 shows that gender does not significantly predict the odds of contracting EVD among the participants while controlling for age, funeral attendance, exposure to body fluids, and contact with a living sick person (*OR* = 0.99, 95% CI [0.706-1.413], *p* = 0.99 and the Wald = 0.00). The result shows that the difference in gender is not associated with the contraction of EVD. As a result, we will reject the alternative hypothesis of statistically significant difference in the odds of contracting EVD between male and female and accept the null hypothesis of no significant odds of EVD contraction between male and female after adjusting for age, funeral attendance, exposure to body fluids, and contact with a living sick person.

Table 13

Logistic Regression Predicting the Likelihood of Ebola Virus Disease Contraction Based on Gender, Age, Funeral Attendance, Exposure to Sick Contact and Body Fluids Exposure with OR, 95% CI, Wald and p-*values*

Variable	B	S.E.	Wald	df	*p*-value	*OR*	95% Confidence interval (C.I.)	
							Lower	Upper
Gender (ref = male)	0.002	0.177	0.000	1	0.993	0.99	0.706	1.413
Funeral attendance (ref = no attendance)	1.746	0.256	46.338	1	0.000	5.730	3.466	9.472
Body fluids exposure (ref = no exposure)	1.213	0.234	26.952	1	0.000	3.364	2.128	5.317
Exposed to sick contact (ref = no contact)	2.134	0.224	90.608	1	0.000	8.451	5.446	13.116
Age of patients	0.010	0.005	3.671	1	0.056	1.010	1.000	1.020
Constant	-2.297	0.251	84.038	1	0.000	0.101		

a. Variable(s) entered on step 1: Gender, Funeral Attendance, Body Fluids Exposure, Exposed to Sick Contact, Age of Patients.

Table 14 shows the result of the logistic regression analysis performed to test whether there is an association between funeral attendance and EVD contraction when controlling for variables such as age and gender. The result of the analysis shows that the *OR* of contracting EVD while participating in funeral rites is statistically significant, *OR* = 4.59, 95% CI [3.08-6.83], $p < 0.05$ and the Wald = 56.19. It is evident from the result that the odds of contracting EVD is 4.59 times higher for people that attend funeral rites. The null hypothesis of no association between the variables can be rejected in favor of the alternative hypothesis of statistically significant difference between the funeral attendance and the contraction of EVD. Therefore, suggesting that the variable funeral attendance in the logistic model does predict the outcome variable EVD contraction as there is an association between the two variables, after adjusting for age and gender. The Chi-square test for association and the logistic regression model confirmed the existence of significant association between funeral attendance and the contraction of EVD.

Table 14

Logistic Regression Predicting the Likelihood of EVD Based on Funeral Attendance with OR, 95% CI, Wald and p-*values*

Variable	B	S.E.	Wald	df	*p*-value	*OR*	95% C.I.	
							Lower	Upper
Gender (ref = male)	0.003	0.135	0.000	1	0.984	0.997	0.766	1.299
Funeral attendance (ref = no attendance)	1.523	0.203	56.190	1	0.000	4.587	3.080	6.831
Age of patients	-0.004	0.004	0.953	1	0.329	0.996	0.988	1.004
Constant	-0.326	0.163	4.006	1	0.045	0.722		

a. Variable(s) entered on step 1: Gender, Funeral Attendance, Age of Patients.

The results from the logistic regression analysis in Table 15 show that the exposure to body fluids significantly influence or predict the odds of contracting EVD among patients when adjusting for age and gender, *OR* = 14.32, 95% CI [10.23-20.04], $p < 0.05$ and the Wald = 240.97. The odds of contracting EVD is 14.32 times higher among patients exposed to body fluids. It is evident that the odds of contracting EVD is a statistically significant among patients exposed to body fluids. The results show that we can accept the alternative hypothesis that there is a statistically significant difference between the exposure to body fluids and EVD contraction and reject the null hypothesis of no association between the exposure to body fluids and EVD contraction. The Chi-square test for association and the logistic regression model confirmed the existence of significant association between body fluids exposure and the contraction of EVD.

Table 15

Logistic Regression Predicting the Likelihood of EVD Contraction Based on Body Fluids Exposure with OR, 95% CI, Wald and p-*values*

Variable	B	S.E.	Wald	df	*p*-value	*OR*	95% C.I.	
							Lower	Upper
Gender (ref = male)	0.086	0.156	0.308	1	0.579	0.917	0.676	1.244
Age of patients	0.008	0.005	2.770	1	0.096	1.008	0.999	1.017
Body fluids exposure (ref = no exposure)	2.662	0.171	240.974	1	0.000	14.320	10.233	20.040
Constant	-1.332	0.203	48.059	1	0.000	0.264		

a. Variable(s) entered on step 1: Gender, Age of Patients, and Body Fluids Exposure.

Table 16 shows the results of the logistic regression analysis conducted to test whether there is an association between the contraction of EVD and the exposure to a living sick person. The results show that the exposure to a living sick person with EVD significantly predict the odds of contracting EVD when adjusting for age and gender, *OR* = 15.34, 95% CI [11.25-20.93], $p < 0.05$ and the Wald = 297.045. The odds of contracting EVD is 15.34 times higher among patients exposed to a living sick person. The odds of contracting EVD is statistically significant among patients exposed to sick contact. The results show that we can reject the null hypothesis of no association between the exposure to sick contact and EVD contraction and accept the alternative hypothesis that there is statistically significant difference between the exposure to sick contact and the contraction of EVD. The Chi-square test for association and the logistic regression model confirmed the existence of significant association between patients' contact to a living sick person and the contraction of EVD.

Table 16

Logistic Regression Predicting the Likelihood of EVD Contraction Based on Exposure to Sick Contact with OR, 95% CI, Wald and p-*values*

Variable	B	S.E.	Wald	df	*p*-value	*OR*	95% C.I.	
							Lower	Upper
Gender (ref = male)	0.013	0.157	0.007	1	0.934	0.987	0.726	1.341
Age of patients	0.010	0.005	4.213	1	0.040	1.010	1.000	1.019
Exposed to sick contact (ref = no contact)	2.730	0.158	297.045	1	0.000	15.340	11.245	20.925
Constant	-1.823	0.220	68.413	1	0.000	0.161		

a. Variable(s) entered on step 1: Gender, Age of Patients, and Exposed to Sick Contact.

Summary of the Results and Findings

In this section, the results and findings from the analysis of secondary data from the 2014 outbreak of EVD in Liberia were examined and presented. This section included the purpose of the study; the baseline representative and demographics of characteristics of the sample; the results of the descriptive statistics that appropriately characterize the sample; the research questions and hypotheses testing; and the key findings. I examined six categorical independent variables (age, gender, county of residence, funeral attendance, exposure of body fluids, and exposure to sick contact) and one categorical dependent variable (contraction of EVD). The Chi-square test for association and Logistic Regression were the two statistical tests used to analyze the variables in the study dataset.

I examined four research questions and hypotheses, including statistical tests of the hypotheses that consisted of the Chi-square test for association, Fisher's exact Chi-square test for values less than five, logistic regression, confidence interval, and the odds ratio for the logistic regression model. In RQ1, I tested whether there was an association between age and the contraction of EVD and between gender and contraction of EVD. RQ1 showed there was a statistically significant association between the different age groups and no statistically significant association between gender and the contraction of EVD. Although the Chi-square test of association result indicated a statistically significant association between age and the contraction of EVD, the logistic regression model shows that there was no significant association between age and EVD contraction after adjusting for gender, funeral attendance, exposure to body fluids, and contact with a living sick person. RQ2 examined the association between the participants' county of residence and EVD contraction. The results from the statistic showed no significant association between the county of residence and EVD contraction.

RQ3 examined the relationship between funeral attendance and EVD contraction. The results showed a significant association between funeral attendance and EVD contraction. RQ4 examined the association between body fluids exposure and contact to living sick person and EVD contraction. The statistical analysis showed a significant association between exposure to body fluids and EVD contraction—between contact with a living sick person and EVD contraction. The results supported the alternative hypothesis of statistically significant difference between exposure to body fluids, contact with a living sick person, and the contraction of EVD.

In the final section (section 4), I will discuss the interpretation of the results and findings from the analysis conducted in this section of the study. The results will be interpreted based on the literature used in this study. I will also provide an analysis and explain the findings in the context of the SEM framework. Finally, I will discuss the implications to positive social change, provide recommendations and describe limitations of the study.

Section 4: Application to Professional Practice and Implications for Social Change

Introduction

The purpose of this quantitative study was to examine the risk factors associated with the contraction of EVD in Liberia. This capstone study was designed to provide evidence on the factors that are associated with the contraction of EVD. This study was a retrospective cross-sectional design that relied on secondary data collected from Ebola treatment facilities during the 2014 outbreak of EVD in Liberia. The secondary data used in this study was provided by the NPHIL. The dataset included independent variables such as patients' age, gender, county of residence, funeral attendance, contact with a living sick person, and the exposure to body fluids, and the dependent variable was the contraction of EVD. Knowing how and from whom people contract diseases can assist in providing information in responding to the disease by limiting the impact of the outbreak (Agua-Agum et al., 2016). Although several studies have identified individual factors linked to the transmission of EVD, very few research studies have examined multiple risk factors that are associated with the contraction of EVD, especially in Liberia. I conducted this study to examine factors that are associated with the contraction of EVD in Liberia.

Summary of the Key Findings

In this capstone study, I examined six categorical independent variables (age, gender, county of residence, funeral attendance, exposure of body fluids, and exposure to living sick persons) and one categorical dependent variable (contraction of EVD). Chi-square test for association, including the Fisher's exact Chi-square test for values less than five, and logistic regression were the two statistical tests used to analyze the variables in the study dataset. A total of 1,658 patients were analyzed in the dataset. The results indicated that among the 1,658 cases, 45.1% (747) of the study participants were female and 54.9% (910) were male. The mean age of the study population was 32.4 years ranging from 0 to 89 years with an *SD* of 16.67 years.

The association between the participants' age and the contraction of EVD was not statistically significant. Although the Chi-square test of association results indicated a statistically significant association between age and the contraction of EVD, the logistic regression analysis showed no significant association between age and the contraction of EVD after adjusting for gender, funeral attendance, exposure to body fluids, and contact with a living sick person. The results showed no statistically significant association between gender (male and female) and the contraction of EVD utilizing both Chi-square test for association and logistic regression model ($p = 0.056$). There is no statistically significant difference in the odds of contracting EVD between male and female after adjusting for age, funeral attendance, exposure to body fluids, and the exposure to sick contact.

The patients' county of residence or where they live was not significantly associated with the contraction of EVD ($p = 0.21$). Cramer's V analysis (Cramer's V = 0.077) shows a very weak association between the patients' county of residence and the contraction of EVD. I also examined the relationship between funeral attendance, body fluids, and contact with a living sick person and EVD contraction. The results showed a significant association between funeral attendance, body fluids, and contact with a living sick person, and EVD contraction ($p < 0.05$). The results of both Chi-square analysis and logistic regression model supported the alternative hypothesis of statistically significant difference between funeral attendance, exposure to body fluids, and contact with a living sick person and the contraction of EVD. This section includes an interpretation of the findings, the limitations of the study, recommendations for future investigation, and the implications for professional practice and positive social change.

Interpretation of the Findings

The primary objective of my study was to examine whether age, gender, patients' county of residence, funeral attendance, exposure to body fluids, and the exposure to living sick persons were associated with the contraction of EVD. In this capstone study, I examined four research questions followed by hypotheses testing. In the first research question, I hypothesized that there was no association between age and the contraction of EVD and that there was no association between gender (male and female) and the contraction of EVD. The results indicated that there was no statistically significant difference between age and the contraction of EVD after adjusting for other variables, such as gender, funeral attendance, exposure to body fluids, and exposure to sick contact. Although the Chi-square test for association showed a statistically significant association between age and the contraction of EVD, the logistic regression model showed that the odds of the likelihood of contracting EVD were not statistically different between the patients' ages. The likelihood of contracting EVD also showed no statistically significant difference between gender (male and female).

In RQ1, I hypothesized a statistically significant association between the patients' county of residence and the contraction of EVD. The results from the Chi-square test for association showed no statistically significant association between the county of residence and the contraction of EVD. In RQ3, I hypothesized no link between funeral attendance and the contraction of EVD. The results showed a statistically significant difference between funeral attendance and the contraction of EVD ($p < 0.05$). The results also showed that the odds of contracting EVD were statistically different among those participating in funeral rites. In RQ4, I hypothesized that there was no association between the exposure to body fluids and the contraction of EVD and no association between contact with a living sick person and the contraction of EVD. The results showed a statistically significant association between the exposure to body fluids and contact with a living sick person and the contraction of EVD after adjusting for age and gender. The odds of contracting EVD is 14.32 times higher among patients exposed to body fluids. The odds of contracting EVD is 15.34 times higher among patients exposed to a living sick person. The Chi-square test for association and the logistic regression model confirmed the existence of a significant association between the exposure to body fluids and patients' contact to a living sick person and the contraction of EVD.

Interpretation of the Findings with Relation to the Peer-Reviewed Literature

Age. In RQ1, I tested the existence of an association between age and the contraction of EVD. I hypothesized that age was not associated with contraction of EVD. The odds ratio from the logistic regression model was not associated with the contraction of EVD after adjusting for other variables, such as gender, funeral attendance, exposure to body fluids, and exposure to sick persons ($p = 0.06$). Although the Chi-square test for association showed a statistically significant association between age and the contraction of EVD, the logistic regression model showed that the odds of the likelihood of contracting EVD were not statistically different between the patients' age. This means that the contraction of EVD was not related to age.

This finding agreed with the study by Li et al. (2015). Li et al. found no significant difference between age groups and EVD mortality ($p = 0.06$). Li et al. used the Chi-square test to determine the association between age and EVD mortality. Li et al. also indicated that older patients with high viral load of EVD and those with diarrhea symptoms have a shorter survival time than other age groups. The study was a retrospective study conducted on 288 patients with confirmed cases of EVD. However, the result of their research study must be interpreted with caution due to the relatively small sample size ($n = 288$). The sample size was significantly small to give a stronger statistical power. The study by Li et al. was only conducted on confirmed cases of EVD.

On the contrary, the findings of this study with regards to age and EVD contraction are in contradiction with other research studies (Furuse et al., 2017; Ji et al., 2016; Bah et al., 2015). Furuse et al. (2017) analyzed laboratory data from 10 EVD laboratories in Liberia that contained information on more than 16,000 samples that were tested for EVD between 2014 to 2005. A thorough review of the laboratory data identified a total of 10,536 patients of which 3,897 were EVD positive, and 6,639 were negative for the EVD. Among the age groups of patients diagnosed with EVD or having contracted EVD, there was an increase among children—ages less than six years; among ages 21-30; 31-40; 41-50; and >60 years ($p < 0.001$) (Furuse et al., 2017). According to

Furuse et al. age (young children and the elderly) was the risk factor for death due to EVD.

Ji et al. (2016) conducted a retrospective observational study on a total of 773 patients with suspected cases of EVD, among which 285 were confirmed cases of EVD. The average and median age of the EVD patients was 29 ± 16 years and 28 years respectively. Ji et al. found that the survival rate of EVD patients age group 0 to 6 years showed significantly statistically lower than that of patients' age group 7 to 59 years ($p > 0.05$) or patient ≥ 60 ($p > 0.05$). Ji et al. also indicated that the survival rates for patients' age group 7 to 59 and ≥ 60 years did not show any statistically significant difference ($p = 0.6621$). The weakness of Ji et al.'s study was that they did not include any discussion about how the sample was determined and selected.

Bah et al. (2015) also found that the association between older age and a worse outcome among the patients with EVD was often attributed to other coexisting conditions including infectious and chronic diseases. Bah et al. found that patients who were 40 years and older as compared with those under the age of 40 years had the odds of death of 3.49 ($p < 0.05$). However, the result of their study must be interpreted with caution due to small sample size ($n = 80$). The findings of the study by Bah et al. can be explained by the fact that as patients' age and their immune system to fight diseases declines, they are easily prone to contract infectious diseases such as EVD. The difference is the outcome of this study and Furuse et al. (2017) can be attributed primarily to the sample size. The statistical significance was calculated using a large sample size ($n = 16{,}370$) in Furuse et al.'s research study compared to 1,658 patients in this study.

Gender. For RQ1, I also tested for the existence of an association between gender and the contraction of EVD. I hypothesized that there was no link between gender (male and female) and the contraction of EVD. The result of the study analysis showed that 47.9% of female tested positive for EVD while 44.5% of the male patients tested positive for EVD. In general, women were slightly more affected by EVD than men, accounting for 48% of all cases. The result of this study also showed that there was no statistically significant association between male and female and the contraction of EVD (p = 0.17). Given that the Chi-square test results were different from most research findings, a binary logistic regression was conducted to further examine the influence of gender on the contraction of EVD. The logistic regression analysis showed that the difference in gender is not associated with the contraction of EVD after adjusting for age, funeral attendance, exposure to body fluids, and contact with a living sick person (p = 0.99).

Although the results of this study regarding gender are similar to the outcome found by Li et al. (2016) and Agua-Agum et al. (2016), they are different from studies conducted by Nkangu et al. (2017) and Furuse et al. (2017). Li et al. found no significant difference between males and females (p = 0.119). Agua-Agum et al. found that gender was not a significant predictor of exposure risk of EVD. Agua-Agum found no difference in exposure risk between male and female and transmission of EVD. In contrast to this study, Nkangu et al. found a statistically significant difference between male and female and the transmission of EVD. Furuse et al. (2017) noted that gender showed significant differences between confirmed cases of EVD and suspected cases that tested negative for the RNA of EVD ($p < 0.001$). The incidence of EVD among women was 34.3%, 95% confidence interval (CI); and men were 30.7%, 95% CI with the $p < 0.001$.

County of residence. In RQ2, I examine the existence of a relationship between the patients' county of residence and the contraction of EVD. I hypothesized that there was no association between the patients' county of residence and the contraction of EVD. The results showed no statistically significant association between the patients' county of residence and the contraction of EVD, X^2 (7) = 9.63, Fisher's Exact test = 9.46, $p = 0.21$, and Cramer's V = 0.077. Cramer's V analysis shows a very weak association between the patients' county of residence and the contraction of EVD. As a result, we will fail to reject the null that there is no association between the patients' county of residence and the contraction of EVD.

The findings in this study are in contrast with the research study by Furuse et al. (2017). In a large retrospective study of over 10,000 participants, Furuse et al. found that place of residence were the risk factors for deaths due to EVD at $p < 0.001$. Furuse at al. found that the participants' place of residence was significantly associated with the fatality of EVD. Furuse et al. noted that the proportion of confirmed cases living in the city area (73%) was higher than the percentage of EVD negative suspected cases (66%) in their study.

Funeral attendance. In RQ3, I tested the association between funeral attendance and the contraction of EVD. I hypothesized that funeral attendance was not associated with the contraction of EVD. The Chi-square test for association showed a statistically significant association between patients that attended funeral rites and EVD contraction

(p < 0.05). The result logistic regression analysis showed that the *OR* of contracting EVD while participating in funeral rites is statistically significant after adjusting for age and gender, *OR* = 4.59, 95% CI [3.08-6.83], p < 0.05 and the Wald = 56.19. It is evident from the result that the odds of contracting EVD is 4.59 times higher for people that participate in funeral rites. The Chi-square test for association and the logistic regression model confirmed the existence of a significant association between funeral attendance and the contraction of EVD.

The findings of this study are in agreement with the study by Caleo et al. (2018); Agua-Agum et al. (2016), Olu et al. (2016), and Dietz et al. (2015) that participation in funeral rites are linked to the contraction and transmission of EVD. Caleo et al. undertook a cross-sectional study to analyze and examine factors affecting the dynamics of EVD transmission and contraction and community compliance with EVD control measures over a period. Caleo et al. found that 48% of household cases of EVD had a history of contact with symptomatic patients and a funeral exposure with dead bodies. Olu et al. further opined that people who had multiple contacts with dead bodies, washing of corpses, and funeral attendance accounted for 80% of EVD cases and were below 35 years of age. The results from the study by Olu et al. found that majority of the contacts at funerals and with dead bodies were linked to the confirmed cases of EVD. The results from the study conducted by Dietz et al. showed that 25.5% of patients with EVD reported having attended funeral rites, of whom 66% reported touching dead bodies. Additionally, Agua-Agum et al. found individuals who participated in funeral rituals and contacted dead bodies were more severely affected cases of EVD.

Exposure to body fluids. The objective of RQ4 was to examine the association between the exposure to body fluids and the contraction of EVD. My null hypothesis of no association between the exposure to body fluids and the contraction of EVD was rejected in favor of the alternative hypothesis of the existence of a significant association. The Chi-square test showed a statistically significant association between exposure of body fluids and the contraction of EVD ($p < 0.05$). The logistic regression model showed that the exposure to body fluids significantly influence or predict the odds of contracting EVD among patients when adjusting for age and gender.

The findings in this study conform to the results obtained by Vetter et al. (2016), Francesconi et al. (2003), and Lindblade et al. (2015). Vetter et al. performed a study to understand the key factors of EVD transmission necessary to control the spread of the disease and implement control measures to protect healthcare workers. Vetter et al. found the RNA of EVD in the body fluids of the participants. Vetter et al. indicated that EVD RNA takes 22 days in saliva after onset, stool takes 29 days after onset, 33 days in a virginal fluid, 44 days in sweat, 38 days in amniotic fluid, nine months in cerebrospinal fluid, 16 months in breast milk, and 18 months in semen. A retrospective study was undertaken by Francesconi et al. (2003) to identify some of the risk factors associated with EVD transmission in Uganda from August 2000 through January 2001. Francesconi et al. noted in their findings that the contact with body fluids showed a strong correlation with a crude and adjusted prevalence proportion ratio. Lindblade et al. indicated that human-to-human spread of the disease occurs through contact with body fluids of a symptomatic infected individual while providing care in health care centers, at home, and during traditional burial rituals.

Contact with a living sick person. In RQ4, I examined whether there was an association between contact with a living sick person and the contraction of EVD. I hypothesized that there was no association between the contact with a living sick person and the contraction of EVD. The results of the Chi-square test showed a statistically significant association between contact with a living sick person and the contraction of EVD ($p < 0.05$). The results from the logistic regression analysis showed that the exposure to a living sick person with EVD significantly predict the odds of contracting EVD when adjusting for age and gender. The Chi-square test for association and the logistic regression model confirmed the existence of a significant association between patients' contact to a living sick person and the contraction of EVD. The results of this study regarding contact with a living sick person are similar to the outcome obtained by Dietz et al. (2015) and Olu et al. (2016). Dietz et al. noted that out of 8,311 participants in the study, 4,885 (59%) confirmed that they had contact with a suspected case-patient or a sick patient within one month of EVD symptom onset. Dietz et al. also indicated that out of 4,885 participants, 558 (11%) reported contact with a critically ill patient. Olu et al. found that 52% of the confirmed cases of EVD had close contact with neighbors suspected case of the disease, while 38% were in close contact with family members.

Interpretation of the Findings in the Context of the Theoretical Framework

The theoretical framework for this research study was based on the SEM. The SEM first employed or utilized by Bronfenbrenner (1979) and later modified by Baral et al. (2013) and the CDC (2015a) to cancer screening initiatives and the assessment of HIV risk factors provided the theoretical foundation of this capstone study. The SEM provided information at the individual, interpersonal, community, and policy levels of how and when individuals can recognize the risk factors such as contact with a living sick person, touching dead bodies at funerals, and washing dead bodies before burial associated with the contraction of EVD. The SEM can be adapted to contextualize or understand the risk of EVD contraction among people that are vulnerable to the disease (Baral et al., 2013). The application of the SEM to investigate the risk factors associated EVD can be utilized at the (a) individual level (identifying factors such as age and gender); (b) interpersonal level (examining close relationships and contacts and the exposure to body fluids which may increase the risk of EVD); (c) community level (examining communities and counties of residence); and (d) environmental or policy level (avoiding funeral or burial rituals). I addressed these levels individually.

Individual level. EVD tends to affect all age groups and gender (male and female) (Agua-Agum et al., 2016; Nkangu et al., 2017; and Furuse et al., 2017). Even though my study did not find a strong statistically significant association between age and the contraction of EVD and between male and female and the contraction of EVD, yet other research studies have found an association between age and the transmission of EVD and between gender and the transmission of EVD. According to a study conducted by Nkangu et al. (2017), the differences among the 20,035 cases of EVD reported in Liberia, Guinea, and Sierra Leone during the 2014 EVD outbreak—males and females had a similar average rate of contracting EVD with the frequency of exposure higher among females than males. Fawole et al. (2016) reported that from 1976 to 2012, over 1530 people died from previous EVD outbreaks in Africa compared with more than 11,300 deaths from the 2014 outbreak—females were affected the most due to their time spent at home and caring for the sick. During the EVD outbreaks, women were on the frontline as caregivers in homes, communities, and as healthcare workers providing care for sick. Gender or sex-specific differences can play a significant role in creating public health measures to reduce the community-based spread of EVD (Agua-Agum et al., 2016). Understanding and identifying age groups who contracted and died from EVD is critical for determining the effect of planning public health response and interventions. Analyses of data from 2014 to January 2016 EVD outbreak revealed that there were differences in age between EVD cases and non-EVD suspected cases (Furuse et al., 2017). According to Healthy People 2020 (2019), the health status and health behaviors of a nation are determined by influences at the individual, interpersonal, community and policy levels.

Interpersonal level. Understanding and identifying close relationships and contacts and the exposure to body fluids are vital for examining the public health initiatives at the interpersonal level of the SEM theoretical framework. People at higher risk of contracting EVD include family members, healthcare workers, and those who have close contact and relationship with infected persons or who have contact with dead bodies during funeral rites and burying rituals (Coltart et al., 2017). According to Coltart et al. (2017), the disease often arises from close human-to-human contact at home, healthcare facilities, family member taking care of their loved ones, and more. The initial phases of the outbreak of EVD went unnoticed and led to chains of the infection among the Kissi people on the borders of Liberia, Sierra Leone, and Guinea (Coltart et al., 2017). Failure to control the transmission and contraction of EVD in the early phases of the outbreak of the disease allowed the disease to spread from rural and urban areas affecting many families, communities, and healthcare workers (Coltart et al., 2017). The findings of my study suggest that the exposure to close contact with a living sick person and exposure to body fluids was related to the contraction of EVD in Liberia.

Community level. During the outbreak of EVD in Liberia, Guinea, and Sierra Leone, many communities, towns, and cities were significantly impacted by the outbreak of the disease (Coltart et al., 2017). Many of the people who contracted the disease in the urban area of Liberia transmitted the disease to their respective communities—which led to sustained widespread of the disease that was difficult to eradicate because it was hard to reach communities and remote villages (Lindblade et al., 2015). According to Fallah et al. (2015), more than 320 communities in Liberia were affected by the outbreak of EVD. Lindblade et al. found that 94% of the decrease in the spread of EVD came after the initiation of community interventions in remote rural areas of Liberia during the 2014 outbreak. The United Nations Statistics Division indicates that over 68% of the urban population lives in the network of slums—characterized by overcrowding, lack of basic sanitation, and high crime rates. Some of the communities that had high cases of EVD included the Doe Community, New Kru Town, Logan Town, Clara Town, Jallah's Town, West Point, Slipway, Fiama, Crysaville, Mt. Barclay Town, Jacob's Town, New Georgia, and more (Fallah et al., 2015).

Despite the declined and eradication of EVD cases in Liberia, an increase in the level of interventions is needed to eliminate EVD outbreaks in remote communities (Nyenswah et al., 2014). Early case recognition, detection, and isolation were needed to rapidly contain the outbreaks in hard-to-reach and newly affected communities (Nyenswah et al., 2015). Drawing on conservations with affected communities requires community engagement in identifying community leaders to champion key messages about the prevention and control of the disease; organize regular community meetings; tailoring policies to local community settings; and involving family members in care action that will not expose them to increase the risk of the disease. Effective community engagement can benefit decision-making—a strategy designed to incorporate cultural values, customs, and concerns of communities affected by the outbreak of the disease. In cases where community health programs are initiated, health organizers have the responsibility to engage the community as an authentic partner in changing the health conditions of the community (Healthy People 2020, 2019).

Policy level. High-risk behaviors such as burying rituals or traditional burial practices propagated the spread of EVD (Coltart et al., 2017). According to Coltart et al. over 60% of new cases of EVD in Guinea were to funeral practices, while 80% of new cases of EVD were linked to traditional burials ceremonies in Sierra Leone. Safe burials were an integral aspect of responding to the outbreak of EVD in Liberia (Coltart et al., 2017). Considering that one of the primary means of human-to-human contact and spread of EVD is through direct contact with the dead bodies including funeral and traditional burial practices and contact with infected body fluids (Manguvo & Mafuvadze, 2015).

For example, in Liberia, one of the most important funeral rituals that were common among the people of Liberia was the washing of dead bodies with their bare hands and spending time with the corpse before burial (Coltart et al., 2017). In Sierra Leone, funeral rituals or practices varied with differences between the Christians and Muslim practices––Muslims will wash the corpse and bury the same day, whereas Christians will wait for up to several weeks to make funeral arrangement for their loved ones to be buried (Nielsen et al., 2015).

The most common ritual practices among many tribal groups in Liberia are the washing of dead bodies with bare hand and spending time with the dead body. These traditional practices highlight the need for decision-makers to put in place policies that require safe burial practices. Policy-makers must implement policies that will regulate how funeral practices are handle during funeral arrangement for all groups including Christians, Muslims, tribal groups, and more in Liberia. The Ministry of Health and the NPHIL must collaborate and develop policies to address the shortage in burial space, train communities on proper burial technique, and provide education and training about the disease. The lack of trained burial teams, a shortage in burial space, and the lack of community engagement to facilitate safe burial technique can increase the risks in funeral rituals (Coltart et al., 2017).

Limitations of the Study

In this study, I utilized secondary data to analyze the association between independent variables (age, gender, and funeral attendance, exposure to body fluids, and contact with a living sick person) and the dependent variable (contraction of EVD). The secondary dataset used for this study was provided by the NPHIL. The data were collected for public health response activities during the 2014 outbreak of EVD in Liberia from Ebola treatment facilities. Each Ebola treatment facility kept and managed the medical records of patients including each patient's medical history, triage, laboratory test results, and other relevant information on all the patients. The dataset does not include data from all the various Ebola treatment facilities in Liberia. The study was limited to the laboratory test results and medical records of patients including each patient's medical history, triage, and other relevant information on all the patients. This study was also limited to only patients that were admitted to Ebola treatment units in Liberia. Many records like marital status, educational achievement, and occupation status that could have potentially provided essential data points were not included in the study due to missing information.

To ensure the quality and address discrepancies in the secondary data, the dataset was analyzed utilizing the IBM SPSS Statistic 25. Additionally, the manipulation of the dataset was required to account for missing and incomplete information that could lead to errors—which can jeopardize the validity reliability of the dataset. SPSS was used to analyze the data, check for missing data in the dataset, and more. To control for the missing values in the dataset, I performed a transformation of the variables by automatically recoding the variables in SPSS and treating the blank string values as user-missing. The results of this study may not be a representative of the entire EVD patient population in Liberia. This may pose a threat to validity to the study outcome. Finally, the focus of this study and the data used (collected from Ebola treatment units) are limited to the outbreak of EVD in Liberia. Although other West African nations face similar outbreaks—the results cannot be generalized to other EVD outbreaks in West Africa.

Recommendations

This capstone research study used a quantitative method of approach to examine the risk factors associated with the contraction of EVD in Liberia. There are factors such as educational achievement, marital status, and occupational status not used in this study that pose a challenge to controlling and preventing the contraction of EVD in Liberia. Further research study needs to be done to examine those factors in the context of the findings presented in this study. The relationship between the participants' educational level, marital status, and occupational status should be explored further using quantitative research studies. Hahn & Truman (2015) argued that educational achievement is an essential component and a major contributing cause of health wellbeing and has the potential to improve public health outcomes. Hahn & Truman (2015) also argued that education must be recognized as an essential component for the disruption of poverty and inequalities in making health critical health decision. It is important to know whether educational achievement, marital status, and occupational status were associated with the contraction of EVD in Liberia.

The NPHIL and the Ministry of Health should engage in evidence-based initiatives through research to better understand the trends in the implementation EVD program in Liberia. This event will provide a blueprint for disease surveillance of EVD contraction and transmission in Liberia. Expanding surveillance is critical to preventing, reducing, and controlling preventable diseases and other infectious diseases. Improving disease surveillance will allow for early detection of the spread of disease and emerging infectious diseases (Healthy People 2020, 2019). The increase in disease surveillance will save lives by allowing ample time for public health responses and the development of evidence-based recommendations on disease prevention and control initiatives. Disease surveillance allows for fast information or data sharing, collection, management, and storage. Surveillance enables the facilitation of identifying people in a timely manner that require immediate treatment. The data had missing information and some information such as marital status, educational achievement, and occupational status was not included in the dataset.

Implications for Professional Practices and Social Change

The key to preventing future outbreaks of EVD is to identify risk factors that increase the risks of EVD contraction. The findings of this study provided insights and shed light on the most important risk factors associated with the contraction of EVD. Also, the findings of this study provided insights and help public health and healthcare professionals regarding key factors that contribute to the spread and contraction of EVD. This study can provide ways to prevent and reduce the incidence, contraction, and spread of EVD during an outbreak, especially in Liberia. I examined how the risk factors associated with EVD differ according to age, sex, community and county of residence, contact with a living sick person, contact with dead bodies, and funeral attendance.

This study is among a very few evidence-based research studies that had been carried out to examine multiple risk factors associated with the contraction of EVD in Liberia. The findings of this research study, if implemented, may lead to significant implications for positive social change policies and practices in Liberia—being that even years after the elimination of EVD, no study has been conducted in Liberia to examine multiple risk factors associated with the contraction of EVD. Understanding the relationship between these risk-associated factors will help decision-making process for healthcare and public health professionals and policymakers involved in the concentration of resources, program planning and implementation in areas that might have the most significant impact on EVD prevention, treatment, and control. It is evident from this research study that funeral rites, exposure to body fluids, and contact with a living sick person remain a significant public health issue and threat in Liberia. Therefore, the Ministry of Health and the NPHIL and health decision-making bodies should focus their attention on burial practices, emphasizing safe hygiene practices in public places including schools, hospitals, local health facilities, and more.

This retrospective cross-sectional study examined factors that will minimize the spread of EVD through contact tracing, good hygiene practices, and raising awareness of the risk factors associated with EVD. Propose policy that will mandate safe and healthy practices in schools, community gathering, healthcare settings, public and private burial sites, and more. Education about safe hygiene practices in rural regions of Liberia. Massive public health community awareness, a robust economic capacity building, and great and improved transportation systems can empower communities with the understanding that disease can be prevented, reduced, and eliminated with other strategies other than the reliance on a fear-based campaign about the risk of the disease.

A comprehensive EVD prevention and control initiatives or programs can promote positive social change by focusing on improving the quality of life of underprivileged communities, reducing the rate of poverty, and investing in social, educational, and community-based development programs such as roads, schools, sanitation, health care facilities. Educational and community-based initiatives can encourage health and wellness by educating communities on the danger poses in their lives and well-being. In cases where community health programs are initiated, public health and health care organizers have the responsibility to engage the community as an authentic partner in transforming the health conditions of the community (Healthy People 2020, 2019).

It is very important for health professionals and institutions to provide new opportunities to connect with culturally diverse and hard-to-reach rural communities that will enable quick and informed responses to health risks and public health outbreaks in Liberia. It is unfortunate that the illiteracy rate is very high Liberia. The government of Liberia must concentrate resources to help disseminate massive health awareness programs including EVD prevention and control programs in underprivileged communities. Most rural communities in Liberia do not have access to the internet, television, basic telecommunication system, and more.

Keeping abreast of current research findings regarding the spread of the disease and strategies for prevention is critical for a successful disease prevention program. The findings of this study will help buttress future investigations and may lead to a deeper understanding of the contraction of EVD in Liberia. The results of this study will be used to create public health interventions to raise awareness about the disease—so that people will understand how the virus is transmitted or contracted. Understanding the factors that contribute to EVD is paramount in any EVD program prevention and control initiatives.

Conclusion

During the 2014 outbreak of EVD in Liberia, I lost some immediate member of my family to the contraction and transmission of EVD. This study is very personal to me due to the pain I had to endure from the outbreak of EVD in Liberia. My immediate family member who died during the outbreak of EVD was involved in funeral ritual and in taking care of their loved ones and other people within their communities. Despite the eradication of EVD in Liberia, the virus remains a public health threat in several developing nations in Africa. (WHO, 2019). The current outbreak of EVD in the Democratic Republic of Congo highlight that the virus remains a significant health concern (WHO, 2019). As of February 12, 2019, more than 800 new cases have been reported, including 517 deaths with the overall case fatality rate of 83% in the Democratic Republic of Congo (WHO, 2019). In this study, the risk factors associated with the contraction of EVD was analyzed utilizing a quantitative method of analysis. The findings of this study revealed that funeral attendance, exposure to body fluids, and contact with a living sick person were associated with the contraction of EVD. The results failed to identify other factors such as gender (male and female), age, and community of residence as factors associated with the contraction of EVD.

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Appendix: Data Use Agreement Letter

National Public Health Institute Of Liberia

Preventing and Controlling Public Health Threats

Office of the Deputy Director General
for Technical Services

Ref. No: NPHIL/RL/MPF-DDGTS/026/'18
February 15, 2018

Beyan Y Sana
1124 McAdoo Ave
Gwynn Oak, MD 21207

Attn: Beyan Y Sana

Dear Sir,

Letter of Cooperation to Conduct Research on Ebola Virus Disease in Liberia

Your request to obtain permission to conduct research on the "Determinants and Risk Factors Associated with the Incidence of Ebola Virus Disease Transmission and Control in Liberia" as described in your doctoral premise has been received and reviewed. Based on the review of your doctoral premise and confidentiality agreement to protect patients' information in the secondary dataset, I hereby grant you permission to gain access and use the archival data for secondary analysis on Ebola Virus Disease.

Please make sure to keep all information in the dataset confidential. Do not discuss or disclose any information in the dataset with others; do not make any unauthorized transmissions, inquires, modification or purging of confidential information. I hope that the results and recommendations of your research study will provide useful information that will enhance the implementation of positive social change in Liberia—in its efforts to maintain zero transmission and control of Ebola Virus Disease.

Best regards,

Dr. Mosoka P. Fallah, PhD, MPH, MA

P.O. Box 1871, Emergency Operations Center, Congo Town Back Road, 1000 Monrovia, 10 Liberia