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Demographic Characteristics and Response Preparedness of Employed Adults to Ebola Virus Disease in Monrovia, Liberia

Beth Ann Sexton
Walden University

Walden University

College of Health Professions

This is to certify that the doctoral study by

Beth Sexton

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Review Committee
Dr. Vasileios Margaritis, Committee Chairperson, Public Health Faculty
Dr. Aimee Ferraro, Committee Member, Public Health Faculty
Dr. Richard Palmer, University Reviewer, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

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Abstract

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MPH, Liberty University, 2015

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Ebola virus disease (EVD) is a deadly disease with no known cure and it caused an outbreak from 2014-2016 in Western Africa. Liberia had the highest morbidity and mortality; its capital city, Monrovia, was the focus of this study. The purpose of this research was to explore the association between sociodemographic and socioeconomic factors (gender, religion, age, occupation, education, and ward) and the use of preventative hygiene measures and understanding of EVD among working Monrovian adults. This population was chosen because 97% of the Monrovian population is employed, and thus serves as a good source for future public health campaigns. The theory of reasoned action/planned behavior was used as a framework to understand the situational factors, attitudes, and subjective norms about hygiene practices and EVD knowledge among workers. Data were taken from a 2014-2015 cross-sectional survey by the Liberian government and nongovernmental organizations with 1,334 responses from employed Monrovians. Descriptive statistics, chi-square, and binomial logistic regression were used. According to the results, occupation and education were significant predictors of hand sanitizer and bucket with bleach use. Occupation and education were significant predictors of understanding EVD signs and symptoms and understanding how EVD spreads. Education and gender were significant predictors of understanding general EVD knowledge. These results could promote positive social change by revealing the factors related to EVD prevention among working adults in Monrovia, who could benefit from targeted educational campaigns to prevent morbidity and mortality in future epidemics and ensure economic stability.

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Dedication

I want to dedicate this work first to my family and to my God. My parents, Wes and Patti, have been a constant source of love, support, and guidance throughout my entire academic career. If not for them, I never would have had the courage to pursue this endeavor. I am grateful as well to my sister Rachel who has been a source of love and encouragement. To my wonderful husband, Josh, you have done so much for me since beginning this process. Your patience and encouragement are the only reasons I did not quit long ago. Thank you all for believing in me and making sacrifices on my behalf.

There have been several teachers along the way who have been impactful as well. I want to dedicate this work to the following: Dr. Badara, who opened my eyes to doctoral options, to Dr. Holman for teaching me about public health, to Dr. De Silva for your help and instruction, to Mrs. Sheila Welch for creating a love for science in me, for Mrs. Jeanie Schneider who let me explore academically, and to Mr. Smith who believed in me. Thank you all for having confidence in me and making sacrifices on my behalf.

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I am grateful to the rest of my committee including member Dr. Aimee Ferraro, PhD, MPH who has been very kind and helpful, and Dr. Palmer, University Research Reviewer for his hard work and contributions.

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Section 1: Foundation of the Study and Literature Review

Ebola virus disease (EVD) outbreaks have been a major public health concern for decades because of the high morbidity and mortality associated with the disease (Centers for Disease Control and Prevention [CDC], 2018). For example, during the 2014-2016 EVD epidemic in West Africa, 11,310 fatalities were confirmed by the CDC, and it is possible there were many additional cases that were not confirmed (2017). Though new research is emerging, currently there is no cure for the infection (CDC, 2018). It therefore remains the responsibility of those in public health to attempt to prevent—or at the very least limit—the spread of future EVD outbreaks.

Since there is no cure for EVD infection, only supportive therapy such as IV fluids, antidiarrheal medication, and pain medication can be used (Chertow, Kleine, Edwards, Scaini, Giuliani, & Sprecher, 2014). This therapy can be costly, especially if the outbreak is located in a country that already has minimal healthcare resources. Without sufficient esources, countries are forced to ask for assistance. During the 2014-2015 outbreak in West Africa, outside aid workers helped control the spread of the disease (Chertow et al., 2014). Though necessary, this added both additional cost and additional risk in controlling the outbreak, since many of these workers became ill themselves (Chertow et al., 2014). This cost, in addition to the loss of workers during the outbreak, seriously damaged many countries' economies during the epidemic (Gostin & Friedman, 2015).

External aid workers and travelers also have the potential to carry the disease back to their own countries (Rothstein, 2015). Many countries instated quarantine

measures during the 2014-2015 West African EVD epidemic, but some workers and travelers who were exposed to the virus had already traveled back to their home country by the time these measures were in place (Rothstein, 2015). Diseases can spread more rapidly from one country to another as modern modes of transportation, such as flying and trains, become more ubiquitous throughout the world (Rothstein, 2015).

In America specifically, eleven individuals who had traveled from West Africa were treated with EVD, and of those individuals some had returned to the United States before developing symptoms (CDC, 2017b). It is important to remember that it is possible to spread EVD before symptoms begin or when only mild symptoms are presenting (CDC, 2017b). Several Americans died as a result of the 2014-2016 outbreak, including a doctor and other aid workers (CDC, 2017b).

While there is still a lot that remains unknown about EVD, it is well understood that the virus is spread through body fluids (CDC, 2018). Individuals who protect themselves from contaminated body fluids through proper hygiene are more likely to avoid infection (CDC, 2018). Increasing proper hygiene campaigns in at risk countries like Liberia may be an appropriate step to prevent another deadly epidemic. To do this effectively, it is important to ascertain how much individuals already know about both the virus and the measures that can be taken to prevent the spread of infection.

A survey conducted in Monrovia, Liberia, during the 2014-2016 outbreak asked individuals what they knew about EVD and what they knew about hygiene measures that could be taken to avoid infection (Humanitarian Data Exchange, 2017). Within, this population, those who were employed will be looked at specifically in this study

(Humanitarian Data Exchange, 2017). Around 97% of the population in Liberia is employed (CIA, 2018). Employed individuals are more likely to be exposed to the disease because they are leaving their homes, and they are a specific population that can be targeted through future educational campaigns (CDC, 2018).

Ultimately, if there is another EVD outbreak in Liberia, improving preventative measures among employed Liberians may protect both individuals and the economy by limiting the spread of disease and thus reducing morbidity and mortality associated with it. Basic hygiene improvements may even reduce the morbidity and mortality associated with other diseases (CDC, 2018). Finally, employers may realize from this work that they have an opportunity to reduce the spread of disease through workplace education.

This chapter is organized into six sections. The first section provides the background of this study. The second section provides the problem statement, and the third section provides the purpose of the study. The fourth section includes both the research questions and the hypotheses. The fifth section examines the theoretical framework of the study. The sixth section covers the nature of the study. Final parts of this section include the definition of terms, assumptions, scope and delimitation, limitation, significance, and summary.

Background

Historical Perspectives on EVD

The first major outbreaks of EVD occurred during the 1970s in the Democratic Republic of the Congo (DRC; Li & Chen, 2014). It was nearly 2 decades later before another outbreak was reported (Li & Chen, 2014). Since the 1990s, outbreaks have

occurred in several countries, including the Democratic Republic of the Congo, Gabon, and Uganda (Li & Chen, 2014). Most outbreaks have been isolated and have occurred in countries near or around the equator in Africa (Li & Chen, 2014). There have been isolated cases in other countries, including the U.S. (Li & Chen, 2014).

These cases are rare and have typically occurred when a sick animal has been transported from Africa for research purposes (Li & Chen, 2014). A table showing the location of previous EVD outbreaks up to the present epidemic, as well as case numbers and fatality rates, can be seen below in Table 1.

Table 1

List of EVD Outbreaks

Country	Cases	Deaths	Year
Democratic Republic of the Congo (DRC)	Ongoing	Ongoing	2018
DRC	8	4	2017
DRC	66	49	2016
Multiple	28652	11325	2014-2016
Uganda	6	3	2012
DRC	36	13	2012
Uganda	11	4	2012
Uganda	1	1	2011
DRC	32	15	2008
Uganda	149	37	2007
DRC	264	187	2007
South Sudan	17	7	2004
Republic of Congo	35	29	2003
Republic of Congo	143	128	2002
Republic of Congo	57	43	2001
Gabon	65	53	2001
Uganda	425	224	2000
South Africa	2	1	1996
Gabon	60	45	1996
Gabon	37	21	1996
DRC	315	250	1995

Ivory Coast	1	0	1994
Gabon	52	31	1994
South Sudan	34	22	1979
DRC	1	1	1977
South Sudan	284	151	1976
DRC	318	280	1976

Note. List of EVD Outbreaks. CDC. (2018b). EVD Distribution Map: Cases of EVD in Africa 1976 to 2017. https://www.cdc.gov/vhf/EVD/history/distribution-map.html

Ecology and Transmission of EVD

The primary means of initial transmission of EVD during an epidemic has been zoonotic (Li & Chen, 2014). Swine, monkeys, and humans are all known carriers and fruit bats have been confirmed as reservoirs for the virus (Li & Chen, 2014). Often, humans come into contact with these animals when seeking a food source. This is termed a spill over event which means that the virus can now cross species into humans (CDC, 2016b). Monkeys in particular are a common food source in many African countries (Rizkalla, Blanco-Silva, & Gruver, 2007). Also called "bush meat," monkeys are found in abundance in some areas and are relatively easy to hunt because of their large size (Rizkalla, Blanco-Silva, & Gruver, 2007). In some instances, bats may also be consumed as food (Rizkalla, Blanco-Silva, & Gruver, 2007).

Known Risk Factors for Ebola Virus Disease

Consumption or interaction with bush meat or wild animals in Africa is one known ways that EVD may be introduced into a population (Rizkalla, Blanco-Silva, & Gruver, 2007). Hunters who kill and consume or sell bush meat may not realize the animal is sick, since some animals can be contagious without displaying symptoms. However, some hunters may still sell or consume a sick animal out of desperation for

food or income. Individuals who buy these animals in a market may not see any visual signs that the meat is diseased (Rizkalla, Blanco-Silva, & Gruver, 2007).

Caregivers for the sick are another at risk group. Specifically, women are more at risk for contracting EVD (Suwantarat & Apisarnthanarak, 2015). This is because, culturally, women are given the task of tending to the children and also often assume the responsibility of caring for those who are unable to care for themselves within the extended family (Suwantarat & Apisarnthanarak, 2015). Extended family often includes primarily the older, but may also include younger siblings in some situations (Suwantarat & Apisarnthanarak, 2015).

Proper precautions to prevent transmission may not be taken by caregivers for several reasons. In many areas, access to healthcare is limited or costly (Boozary, Farmer, & Jha, 2014). Second, because EVD mimics the symptoms of many other diseases, it is possible that some caretakers assume their patient is sick with something other than EVD (Beeching, Fenech, & Houlihan, 2014). Even if EVD is suspected, limited resources may inhibit a caretaker's ability to protect themselves (Gatherer, 2014).

Caregivers outside of the immediate family may also be more at risk for contracting EVD. Healthcare workers, such as doctors and nurses, those working in public health, and home healthcare providers such as midwives, are more at risk for exposure. This population is more at risk compared to the general population simply because of the quantity of ill people that they care for on a daily basis. This is to be expected during outbreaks anywhere, but it is important to note that certain additional challenges existed in many areas where the 2014-2016 outbreak occurred. It can be

challenging and time consuming to put protective measures in place in areas where the healthcare infrastructure is not well developed. Bleach, for example, is one of the few disinfectants that can effectively kill EVD and not all small clinics in West Africa had or have enough bleach on hand to deal with an outbreak (Gee & Skovdal, 2017). PPE or proper protective gear for doctors and nurses should ideally include a complete body covering, including shoes, double gloves, and a face shield (Gee & Skovdal, 2017). These are not items that are commonly available or routinely worn when available in most clinics throughout Africa (Gee & Skovdal, 2017). Therefore, these steps for protection may not be in place when the first patients arrive (Gee & Skovdal, 2017). Sometimes individuals are misdiagnosed as well, thus leading to an even further delay in healthcare providers taking correct protective measures and thus increasing the chance of nosocomial infections (Gee & Skovdal, 2017).

Finally, some people are at risk who are exposed to more body fluids than others. Children who breast feed are more at risk of contracting the disease from the mother (Bausch, et al., 2007). Men who engage in intercourse after recovering from the disease are more likely to spread the disease to their partners through their semen (Bausch, et al., 2007). Healthcare workers who tend to the body fluids of patients can be more at risk, such as nurses who change bedding or bed pans (Suwantarat & Apisarnthanarak, 2015). Similarly, anyone who prepares a body for a funeral and comes into contact with body fluids through that process may be more likely to contract the disease (Pandey, Atkins, Medlock, Wenzel, Townsend, Childs, & Galvani, 2014).

Problem Statement

In 2014, an EVD outbreak erupted in Western Africa (CDC, 2017). Three countries, Liberia, Sierra Leone, and Guinea, experienced the highest number of cases from the epidemic with the greatest degree of morbidity and mortality coming from Liberia (CDC, 2017). At one point during the epidemic in Liberia, over 800 individuals a week were being diagnosed with EVD (CDC, 2017). Though EVD is difficult to contain, the spread of the disease may be slowed down through public health education campaigns (CDC, 2018).

One possible public health campaign could have targeted working adults in Liberia. In Liberia, over 97% of the adult population report working in some capacity (CIA, 2018). A large portion of the population could, therefore, be reached through workplace EVD education initiatives. Currently, there is no research that shows how much workers know about EVD and about preventative hygiene.

However, there is research showing how non-pharmaceutical public health campaigns have reduced the spread of disease during other pandemics. In an article by the CDC (2006), the effectiveness of public health campaigns in major disease outbreaks were explored. The article looked only at pandemics in the last century and how public health responded to them. A pandemic is a disease outbreak that effects a large geographic area including more than one country (CDC, 2006). Specifically, the CDC looked at the 1918 flu pandemic and SARS pandemic in Eastern Asia. The 1918 flu pandemic was explored in the article because it was the worse pandemic since the Black Plague. The 1918 flu public health campaign was also the first public health campaign in

America that specifically looked at methods of public health to slow a pandemic (CDC, 2006). The SARS pandemic was explored because it is one of the most recent influenza pandemics, and because extensive public health measures were used to prevent it from becoming worse (CDC, 2006).

What the article found is that in some past epidemics, such as during the 1918 flu pandemic, quarantine measures were not enough to contain the disease and keep it from spreading to other areas (CDC, 2006). The article suggests that more than just quarantining has to be used to stop an outbreak of any kind (CDC, 2006). With SARS and other recent flu outbreaks throughout the world, research has investigated exactly what public health measures may work to reduce spread of disease beyond just quarantining. One multivariate case control study in Hong Kong found that those who washed their hands more than 10 times a day were less likely to contract respiratory illnesses (CDC, 2006). EVD is not considered to be a respiratory illness, but like SARS and other respiratory illnesses, the spread of EVD has been proven to be reduced through hand washing (CDC, 2018). Hygiene education and public health education about diseases and how they spread may therefore be an essential part of stopping communicable disease outbreaks.

Another aspect of this problem is that such a high rate of illness not only resulted in high mortality rates, it also had a damaging effect on the country's economy (Adegun, 2014). Economies suffer during epidemics for many reasons. Businesses lose workers, people are afraid to get out into the public, and often tourism and trade also decline (Adegun, 2014). During the 2014-2016 outbreak, an estimated $2.2 billion was loss in

GDP in Liberia, Sierra Leone, and Guinea (CDC, 2016). Significant financial losses occurred in the areas of private sector growth, agricultural production, and cross- border trade (CDC, 2016). To ensure the stability of Liberia's economy in case of a future epidemic, it is imperative that measures be taken to protect the working class. These same measures may have global implications, since no country is totally immune to the possibility of an epidemic.

The endemic countries in Africa were not the only countries whose economies were affected by the outbreak. The United States alone donated over $2 billion to efforts in Western Africa to contain the disease (CDC, 2016). Countries like the United States, Great Britain, and Germany paid out large amounts of money to ensure that the affected countries had the resources they needed (CDC, 2016). Without these resources, the disease could have spread from Africa to the donor countries, so it was seen as a necessary expense (CDC, 2018).

Widespread food shortages were another problem that occurred during the EVD outbreak of 2014-2016 (CDC, 2016). As mentioned, many individuals were unable to work during the epidemic, leading to a loss in agricultural production (CDC, 2016). The loss of agricultural production was severe enough that it led to food insecurity throughout the affected regions (CDC, 2016). Food insecurity persisted as a serious issue long after the epidemic ended (CDC, 2016). It has taken these countries a long time to recover in this particular area (CDC, 2016).

It is also important to note the impact the EVD outbreak had on healthcare systems throughout Western Africa. During the outbreak, 881 healthcare workers became

infected with the disease, of which 513 died (CDC, 2016). It is estimated that overall healthcare services were reduced by up to 50% (CDC, 2016). This created multiple problems. First, during the outbreak it was difficult to adequately treat the large number of incoming EVD patients in healthcare facilities when the facility was short staffed (Gee & Skovdal, 2017). Secondly, other diseases became less of a priority, leading to a surge of deaths caused by HIV/AIDS, malaria, and tuberculosis. Some of these deaths may have been because some patients with other diseases were afraid of contracting EVD if they sought care at a facility that also saw EVD patients (Gee & Skovdal, 2017). For patients with other diseases who did seek care, it is believed that these patients were no longer getting adequate care because care facilities were short staffed. It has been estimated that an additional 10,600 lives were lost to HIV/AIDS because of inadequate care during this time (CDC, 2016).

Finally, this epidemic had a huge impact on children in Western Africa. Nearly 20% of all EVD cases were children (CDC, 2016). It is also estimated that after the epidemic ended, over 17,000 orphans were left as a result of the disease (CDC, 2016). During the outbreak, children suffered academically with some areas cancelling school for close to 30 weeks (CDC, 2016). Children also missed out on routine health checks and vaccinations during this time, making them more vulnerable to other infections (CDC, 2016).

This research filled a gap in understanding by specifically looking at whether or not those working in Liberia during the epidemic had adequate knowledge about EVD and its prevention. Literature searches yielded no results when looking for data specific to

this population group in Liberia. However, researchers have cited the need for improved education in Liberia as gaps in current research (Christie, Davies-Wayne, Cordier-Lasalle, Blackley, Laney, Williams,... & Ladner, 2015). Specifically, Christie et al. (2015) found that knowledge about EVD spreading through semen needed to be improved in Liberia. In Nigeria, volunteer health advisors who were already working in a healthcare field during the epidemic showed gaps in EVD knowledge (Patel, Pharr, Ihesiaba, Oduenyi, Hunt, Patel, ... & Ezeanolue, 2016). It is possible that there is a similar deficit of knowledge among workers in another West African nation, Liberia.

Literature searches also revealed that a similar approach to understanding EVD knowledge in the United States yielded interesting results. First, those in the United States with more knowledge about EVD were considered to have a lower risk of contracting the disease if it came to the United States (Rolison, & Hanoch, 2015). Second, research found that increasing knowledge about EVD led to individuals taking the disease more seriously (Rolison, & Hanoch, 2015).

Social change may occur when businesses realize that they have an opportunity to educate a large portion of the Liberian population. Secondarily, social change may occur if individuals follow the guidance/training offered by their organizations, resulting in less illness and fewer businesses losing workers in the future. When businesses are able to function during an epidemic, the economy suffers less loss and thus many vulnerable populations who rely on economic assistance remain unharmed.

Purpose of the Study

The aim of this study was to investigate the impact of employed adults' socioeconomic and demographic factors on the use of EVD preventative measures. This study could be used to inform future public health campaigns among working adults. Workplaces offer a way to get information to large groups of individuals at a time (Gee & Sokval, 2017). Workplaces can also serve as a great place to begin to enforce proper hygiene practices that may then be done at home as well, once the individual knows what to do (Gee & Sokval, 2017). Seeing others participate in these programs can also serve as a form of positive peer pressure (Gee & Sokval, 2017). This study was conducted to reveal whether or not working adults were more or less educated about EVD than those who did not work and may therefore offer insight into whether or not workplace education is being done.

Research Questions and Hypotheses

This study was guided by the following two research questions:

1. Is there an association between socioeconomic and demographic factors (education, age, gender, and occupation) and frequency of employed adults who report the use of preventative hygiene practices (use of hand sanitizer and bleach) in Monrovia, Liberia?
    a. $H1_0$: There is no statistically significant association between socioeconomic and demographic factors and frequency of employed adults who report to use preventative hygiene practices in Monrovia, Liberia.

b. $H1_A$: There is a statistically significant association between socioeconomic and demographic factors and frequency of employed adults who report to use preventative hygiene practices in Monrovia, Liberia.

2. Is there an association between socioeconomic and demographic factors (education, age, gender, and occupation) and frequency of employed adults who report understanding the basic nature of the EVD (common symptoms and how it is spread) in Monrovia, Liberia?
   a. $H1_0$: There is no statistically significant association between socioeconomic and demographic factors and frequency of employed adults who report understanding the basic nature of the EVD in Monrovia, Liberia.
   b. $H1_A$: There is a statistically significant association between socioeconomic and demographic factors and frequency of employed adults who report understanding the basic nature of the EVD in Monrovia, Liberia.

Nature of the Study

A cross sectional survey was used as the secondary data source for this research. The survey was conducted by a Liberian NGO, called Parley, which is a partner with the United Nations which, in turn, runs the Humanitarian Data Exchange (2017). According to the Humanitarian Data Exchange (2017), the survey selected 77 communities from 15 wards in the capital of Monrovia (). The number of communities chosen from each ward was proportional to that ward's population size, so no ward was under- or overrepresented in the survey (). Households surveyed from each community were

randomly chosen (). In the survey, individuals were asked about their awareness of EVD as well as the steps they had taken to prevent EVD infection (). The study also recorded the individuals' occupation, gender, and education ().

The survey was conducted from December 2014 to January 2015 (Humanitarian Data Exchange, 2017). At this point, EVD had been present in Monrovia for approximately six months (CDC, 2018). The survey asked questions about hand hygiene and the nature of the EVD virus, for example, how it is spread, how to know if you have it, etc. (Humanitarian Data Exchange, 2017). These results were divided based on education, age, occupation, and gender to see if there was a correlation between any of these sociodemographic/socioeconomic factors listed and knowledge about EVD and the prevention of EVD through improved hygiene.

Population

The population of the survey included representation from every community in Monrovia (Humanitarian Data Exchange, 2017). Monrovia is the capital of Liberia and has a population of over 1 million, nearly a fourth of the country's total population (CIA, 2018). Those living in Monrovia have faced many challenges, including civil wars (CIA, 2018). The most recent war ended in 2003, but when the EVD epidemic struck Monrovia in 2014, the city had not yet fully recovered (CIA, 2018). The war combined with other health issues, like high fertility rates, likely contributed to the fact that a majority of the population (almost 60%) was under the age of 25 (CIA, 2018).

Currently, Liberia is considered a low-income nation, though a majority of the population does work (CIA, 2018). Major industries include mining and agriculture (CIA,

2018). A majority of the population also lives without access to improved sanitation, which is a factor being explored (CIA, 2018). In urban areas like Monrovia, it is estimated that 72% of the population does not have access to improved sanitation like waste disposal and clean water (CIA, 2018).

Theoretical Foundation for the Study

The theory of reasoned action/planned behavior is applicable to EVD prevention (Fishbein, 1979). This theory assumes that most health-related decisions are rational decisions that lead to planned behavior (Bensley & Brookins-Fisher, 2003). Preventative hygiene and understanding how disease is spread may lead to better informed citizens and thus better planned actions/behaviors (Bensley & Brookins-Fisher, 2003). Therefore, the first step is to know which demographic groups of workers need to be a focus of new interventions so that beliefs about EVD can be changed. Second, it is important to know which demographic groups of workers are at risk, so EVD infection may be prevented through targeted educational campaigns designed to meet the specific issues (CDC, 2018).

Under this theory, specifically the situational factors, attitudes, intentions, and subjective norms about hygiene practices among workers will be explored to determine which demographic groups of workers need to be targeted (Bensley & Brookins-Fisher, 2003). First, certain occupations may have situational factors that cause those groups to be more at risk for contracting the disease than others (CDC, 2018). Miners, for example, are in close proximity to bats and may be more at risk of contracting the disease, and funeral and healthcare workers may come into more contact with body fluids than other

occupations (CDC, 2018). This may mean that these individuals know more about EVD and thus use more preventative hygiene techniques then other occupations which are less likely to be exposed.

Attitudes and intentions may also vary across different demographic groups of workers based on individual level of education. Some occupations require educational experience while others do not. A study by Oladimeji, Gidado, Nguku, Nwangwu, Patil, Oladosu,... & Musa, found that healthcare workers with more education, such as doctors, were more likely to practice good hygiene (2015). Healthcare workers with less education did not practice hygiene techniques adequately (Oladimeji et al., 2015).

Finally, subjective norms about hygiene may vary among different ages, genders, and different occupations. Occupations that earn less money may not have as a high of a standard for preventative hygiene, since it can be costly to purchase things like soap, clean water, and hand sanitizer (Doocy & Burnham, 2006). Whether or not hygiene practices are more of a norm among a certain gender or age was explored as well. In one scenario, bathroom handwashing rates in a service station were recorded (Judah, Aunger, Schmidt, Michie, Granger, & Curtis, 2009). It was discovered that men in particular were less likely to wash their hands than women and thus needed to be targeted differently with public health campaigns (Judah, Aunger, Schmidt, Michie, Granger, & Curtis, 2009). Men were more likely to wash their hands if a picture reminding them to wash their hands contained disgusting facts about germs (Judah, Aunger, Schmidt, Michie, Granger, & Curtis, 2009). Women did not need to be disgusted in order to wash their hands more often? (Judah, Aunger, Schmidt, Michie, Granger, & Curtis, 2009). For

women, an advertisement reminding them to wash their hands was sufficient (Judah, Aunger, Schmidt, Michie, Granger, & Curtis, 2009). Finally, different ages may be more at risk for disease due to socioeconomic factors. According to Maharaj (2012), the older may be more at risk for disease due to poverty and lack of access to healthcare.

Literature Search Strategy

For the literature review, two research strategies were used. First, several databases (list them all here, database1, database2, database3, and Google Scholar) were used to find peer-reviewed scholarly articles on the topic. The following keywords were used: *EVD in Liberia, the history of EVD, EVD, the history of Liberia, the Theory of Reasoned Action/ Planned Behavior, and the culture of Liberia*. All searches were limited to the years 2008 to 2020, though some primary sources outside of this range were included. Little research was found on how much employed adults knew about the EVD virus in Liberia. Therefore, I explored how these factors were associated with EVD virus fatality in previous outbreaks in other countries in Western Africa.

Secondly, the CDC, CIA World Factbook, and the World Health Organization were accessed directly. The CDC and WHO both have pages dedicated to information on EVD that can be searched by country. The CIA World Factbook has a page on Liberia, from which some information was derived. All of these sites are updated regularly. Information from these sites was not older than 2014.

Finally, census data were used from the 2008 household census in Liberia. These were collected and published online through the Liberia Institute of Statistics and Geo-

Information Services (LIS-GIS). This census was government sponsored and therefore had reliable oversight in its distribution and publication.

Introduction

EVD has been cited by the WHO (2018) as one of the ten most serious diseases in the world today. This disease has baffled scientists for decades and there still remain many unanswered questions about the disease (WHO, 2018). Fortunately, there are some basic facts about the nature of the disease, how it is spread, and how it may be prevented that offer some insight into possible prevention techniques (WHO, 2015). All of these topics were explored in further detail throughout this section.

About EVD

EVD is a violent and often lethal infection caused by a virus from the family Filoviradae (Beeching, Fenech, & Houlihan, 2014). There are two types of hemorrhagic fevers included in this family: Marburg and EVD (Li & Chen, 2014). Though similar, EVD has been the virus of most concern over recent years since the 2014 outbreak in West Africa (Li & Chen 2014). There are five known species of EVD viruses: Zaire, Sudan, Reston, Tai Forest (which was also known as Cote d'Ivoire EVD virus until 2010), and Bundibugyo (Li & Chen, 2014). The Sudan and Zaire strains are known to be the predominant species associated with recent epidemics (Li & Chen, 2014). The fatality rates for all five strains vary but may be as high as 90% in some instances (Li & Chen, 2014).

In order to contract the disease, one must come into contact with infected body fluids from an EVD patient (Beeching, Fenech, & Houlihan, 2014). Once exposed, it

takes 1- 21 days to develop symptoms depending on age, health, and strain of the virus (Beeching, Fenech, & Houlihan, 2014). At first, symptoms may include high fever, fatigue, nausea, abdominal pain, and vomiting (Beeching, Fenech, & Houlihan, 2014). This makes the virus difficult to distinguish from many other diseases including malaria and cholera (Beeching, Fenech, & Houlihan, 2014). After these symptoms manifest, a patient may then develop unexplained bleeding or bruising (Beeching, Fenech, & Houlihan, 2014). Bleeding and bruising are indicators that the patient has a hemorrhagic virus and further testing must be done to determine what hemorrhagic fever has presented (Beeching, Fenech, & Houlihan, 2014).

A patient is considered contagious as soon as he or she has presented any of the previously mentioned symptoms (Beeching, Fenech, & Houlian, 2014). Once symptoms develop, the virus multiplies inside the body rapidly (Bausch, Towner, Dowell, Kaducu, Lukwiya, Sanchez, & Rollin, 2007). The virus may be present once a patient is symptomatic in the saliva, mucous, tears, breast milk, and semen (Bausch, et al., 2007). The virus may survive in body fluids even after death and has been proven to survive in semen for up to 40 days after symptoms have ended (Bausch et al., 2007).

The 2014- 2016 EVD Outbreak in West Africa

In December 2013, Guinea reported its first cases of EVD to the World Health Organization, and in March 2014 the WHO released a statement about the outbreak that would go on to kill thousands across primarily three countries (Gatherer, 2014). The disease spread west from Guinea into Liberia and Sierra Leone. Cases were reported in Monrovia, Liberia in 2014. This is unique since in the past most EVD outbreaks have

occurred in remote settings (Gatherer, 2014). The spread of the epidemic into an urban center presented new challenges to managing the disease in a dense population (Gatherer, 2014).

This particular epidemic was the largest EVD epidemic because of the number of cases reported as well as because of the large geographic area that was affected (Gomes, Piontti, Rossi, Chao, Longini, Halloran, & Vespignani, 2014). Though response was rapid, the disease continued to spread rapidly throughout Western Africa (Gomes, et al., 2014). After months of efforts by the World Health Organization and others to contain the virus and set up EVD Treatment Centers, the epidemic was declared over in December 2016 (WHO, 2018). A total of over 28,000 cases were confirmed and many more suspected (WHO, 2018).

The 2014-2016 EVD Outbreak in Monrovia, Liberia

As of the 2008 census, Monrovia, Liberia contained over a fourth of the entire population of the country of Liberia or around 970,000 individuals (LIS-GIS, 2008). As the capital city of Liberia, Monrovia has served for decades as the Liberian hub of commerce and trade (LIS-GIS, 2008). However, at times Monrovia has had set backs. In the 1990s a violent civil war took place in Liberia leaving thousands of orphans and damaging nearly every infrastructure in Monrovia (Huband, 2013). Though the 2014 EVD outbreak occurred years later, Monrovia was still recovering from the war (Huband, 2013). As a result, in many respects the city was considerably vulnerable when the disease hit.

In a dense population setting like Monrovia, disease has the opportunity to spread more rapidly even when sound infrastructure is in place (Eisenstein, 2016). Individuals are forced into closer proximity due to volume which may be increased even more so in cities with limited resources (Eisenstein, 2016). Diseases like EVD spread quickly when urban centers lack adequate housing and sanitation (Eisenstein, 2016). Though the city has made great developmental strides over recent years, there are still areas in Monrovia that could be improved (Eisenstein, 2016). EVD entering this city created a challenge for those attempting to contain the virus. It is important to establish prevention techniques in case this disease or others spread into the city again before the city has completely rebuilt.

Possible Prevention Techniques- The Role of the Workplace

There are certain universal precautions that may be taken to lower the risk of contracting EVD. During an EVD outbreak, individuals who work in healthcare or who prepare bodies for funerals should use PPE or proper protective equipment (Suwantarat & Apisarnthanarak, 2015). For EVD, this should include facial shields, gloves, boots, and multiple layers of protective clothing. Individuals who work outside of healthcare should get loved ones suspected of having the disease to a hospital immediately and not try to devise their own PPE at home (Suwantarat & Apisarnthanarak, 2015).

During an outbreak, everyone should adhere to locally mandated curfews and quarantine measures, report suspected cases, and practice good hygiene (Pandey et al., 2014). Good hygiene includes the use of bleach to clean possibly contaminated items and the use of soap and water or hand sanitizer after being in public (Gatherer, 2014).

Additionally, no one should consume or handle bush meat (Rizkalla, Blanco-Silva, & Gruver, 2007).

The WHO (2015) investigated best practices that could be used to prevent the spread of EVD through improved hygiene and infection control. It was recommended that these practices be shared with healthcare workers to reduce the spread of the disease among this population (WHO, 2015). These recommendations include steps that anyone can take to reduce the spread of disease. This information therefore would also be beneficial to share in many other professions. It is one hope of this research that an educational campaign may develop to improve workplace hygiene. This paper by WHO lays out the procedure for improving workplace hygiene.

Improving workplace hygiene would be a logical step to reduce EVD outbreaks since according to the CIA, in 2014, the unemployment rate in Liberia was only 2.8% (CIA, 2018). Though much of the country still falls beneath the poverty line, the majority of its citizens are employed to some degree. Employers could reach their employees through workplace educational programs and thus also reach a large portion of the population (CDC, 2016). In the SARS outbreak and during the 1918 flu outbreak, workplaces, dormitories, schools, and other confined groups were targeted by public health workers (CDC, 2016). Hygiene programs in many instances worked to reduce some of the illness being transferred in these confined groups (CDC, 2016).

In order to conduct a successful workplace education program, it is wise to consider that certain groups within this population may be more or less at risk. Individuals may be more or less at risk based on their age, gender, occupation, or

education. This assumption is supported by research done by Glynn (2015). Glynn found in his research that there exists variability in EVD virus infection rates among different age groups and sexes though the reason for this trend is unknown.

In addition to certain ages and sexes being more at risk, a situation report published by WHO (2016) noted that healthcare workers were more at risk for catching EVD. While this group may be more educated about EVD, they are still being exposed more than the general population (WHO, 2016). It is possible that other occupations are more at risk as well. The CDC notes that those who interact with dead bodies for example may also be more at risk (2018).

Decreasing the spread of disease in the workplace not only saves lives, it saves incomes. Arbogast, Moore-Schilts, Jarvis, Harpster-Hagen, Hughes, and Parker (2016) found that hand hygiene education amongst employees significantly reduced various types of illnesses and absenteeism in the workplace. In an epidemic, this will stabilize the national economy by ensuring that vital businesses continue to stay open, make money, and serve the citizens (Adegun, 2014). This also ensures that individuals are healthy enough to keep working and thus providing financially for their families (Adegun, 2014).

Definitions

ETC or EVD treatment centers. EVD Treatment Centers abbreviated as ETCs on most CDC and WHO maps are hospitals, clinics, or aid stations that have the ability to adequately treat and diagnose EVD through lab techniques (CDC, 2018).

EVD or EVD. EVD commonly abbreviated as EVD is a hemorrhagic fever that caused an epidemic in 2014-2015 throughout Western Africa (CDC, 2018).

EVD Fatality Rates. The number of individuals who died as a result of EVD in Liberia has been calculated and will be used in this study (CDC, 2018).

Hemorrhagic fever. Hemorrhagic fevers are a unique type of illness which can break down capillaries causing both internal and external hemorrhaging (CDC, 2018). The subsequent loss of blood and bodily fluids can easily lead to death without medical intervention (CDC, 2018). Though others exist, the only hemorrhagic fever being studied in this research is the EVD virus (CDC, 2018).

PPE (Personal Protective Equipment). Personal protective equipment sometimes abbreviated as PPE includes protective clothing which is used as standard protocol when dealing with EVD patients (OSHA, 2018). EVD treatment centers would have access to this equipment (OSHA, 2018).

Preventative Hygiene. For EVD, preventative hygiene practices may include washing hands, using hand sanitizer, and the use of bleach (CDC, 2018).

Protective factors. Protective factors is a term that is used in public health to refer to factors that may protect an individual from becoming ill, in this case with EVD (CDC, 2018). One example of a protective factor may have been access to bleach prior to the outbreak (CDC, 2018).

Remission. Remission often refers to someone who has been cured from an illness or is no longer demonstrating symptoms of an illness (CDC, 2018). EVD cannot be cured, but through supportive therapy it is possible for someone to survive EVD (CDC, 2018). Something unique about EVD is that during remission, EVD patients do not have EVD symptoms, but they may still be contagious for a period of time (CDC, 2018).

Individuals may also still have long-term health issues associated with EVD after the disease goes into remission (CDC, 2018).

Supportive therapy. There is no known cure for EVD illness so the only way to treat EVD symptoms is through supportive therapy such as fluids and pain medication (CDC, 2018). What supportive therapy is used can differ based on the illness so it is important to note what can be done for EVD treatment (CDC, 2018).

Viral load. Viral load refers to the amount of virus in a given amount of fluid (CDC, 2018). The viral load necessary to contract EVD is very small (CDC, 2018).

Assumptions

This study was based on the following four assumptions:

1. The survey used was developed through a combined effort of MIT and the Liberian government. It was assumed that the survey was the same one published on the Humanitarian Data Exchange and MIT websites. It was also assumed that the survey was distributed as reported by the Humanitarian Data Exchange.
2. Assumptions have been made for fatality rates used in some references throughout this work. Some cases of EVD may not have been reported due to a lack of immediate relatives, misdiagnosis, or fear of reporting to the government. It was subsequently assumed that these cases were not the majority of cases reported and were ubiquitous in occurrence throughout the country. Because it was assumed that these cases occurred in small proportion

and evenly throughout the country, it was also assumed that they do not create bias in the data.

3. It was assumed that the doctors and treatment centers reporting EVD cases diagnosed the disease accurately and provided the correct data to the World Health Organization.

Scope and Delimitations

This study was based on data collected by Liberian nonprofit organizations and the Liberian government during the 2014-2016 EVD epidemic. Specifically, these data refer to Monrovia, the capital city of Liberia. It was a cross-sectional survey that attempted to get a comparable response rate in each section of the city. The expected response rate was based on population number and did not discriminate based on age, gender, occupation, or religion. These data created certain delimitations.

1. The data used were part of a survey and therefore did not include a control group.
2. This study constitutes an analysis of secondary data and therefore I did not have any contact with patients or any control over data collection.
3. This study was delimited by the information that was collected by doctors in the field.
4. The time of this study delimits the study to only the 2014-2015 outbreak in Liberia and not anywhere else or during any other timeframe.

Limitations

This research has five limitations due to the methods used to collect data.

1. Data may be missing because some respondents could have refused to complete the survey. The investigators did assume that they would not get a 100% response rate when they began the survey (Humanitarian Data Exchange, 2017). The surveyors divided the city into districts and attempted to get a comparable response rate per the population in each district to give an adequate overview of the city as a whole without one district being over- or underrepresented (Humanitarian Data Exchange, 2017). It is believed that this was accomplished, based on the data and based on the investigators' description of the data (Humanitarian Data Exchange, 2017).
2. This survey was reliant on individuals in the field to accurately collect and report the data. Individual error may have occurred, but making the survey short, simple, and electronic may have alleviated some of this concern (Humanitarian Data Exchange, 2017). Investigators were also told to report issues (Humanitarian Data Exchange, 2017).
3. The data collection occurred over several days, so it is possible that data collection changed during that time frame.
4. As cross-sectional research, results will show correlation and not necessarily causation (HHS, 2007).
5. As a cross-sectional survey, a single moment in time is being explored (HHS, 2007). While both populations and knowledge can be dynamic, this survey nevertheless offers an important view of how much people knew about EVD

in the early stages of the epidemic—when public health measures are most important (CDC, 2018).

Significance

During the 2014-2016 outbreak in Liberia, nearly 5,000 people died with over 10,000 confirmed total cases (CDC, 2018). It is imperative to the sustained progress of Liberia to understand how much information the working class in Monrovia received about EVD. This knowledge can inform social change by preventing similar rates of morbidity and mortality in a future epidemic. These individuals are, in a sense, a captive audience with their employers. Results might encourage employers to offer more EVD education to ensure that workers stay healthy. If workers are as uneducated as the rest of the population, then this may reveal a gap in prevention strategies that could be easily resolved through workplace initiatives.

Social change implications include not only saving lives, but the development of better workplace health campaigns that could prevent thousands of workers from having to stay home. This, in turn, would protect the economy which suffered during the epidemic. In Monrovia, 20% of all businesses closed completely during the epidemic (Bowles, Hjort, Melvin, & Werker, 2015). Several issues occurred when businesses closed: an economic decline, increased poverty, and over 75% of the population reported food shortages (CIA, 2018). Education to prevent EVD could reduce the number of individuals who become ill, thus allowing businesses to remain open and serve the public.

Summary and Transition

Though EVD has existed for decades, the most recent outbreak in West Africa was the most devastating, with over 11,000 confirmed EVD virus fatalities (CDC, 2017). This quantitative study used secondary data collected by the Liberian Government, organized by MIT, and published by the World Bank to further understand what sociodemographic and socioeconomic factors among working adults may be associated with EVD fatality in Liberia. The theory of reasoned action/ planned behavior was used to further understand what roles society, communities, relationships, and individuals played in the spread of EVD. These associations were analyzed using regression techniques and SPSS software.

The study's methodology and the analysis plan are described in the Section 2.

Section 2: Research Design and Data Collection

Introduction

In the previous section, I offered an overview of the current literature relevant to EVD outbreaks in Monrovia, Liberia. A survey was conducted in Liberia during the early phases of the most recent outbreak of EVD in Liberia in 2014 (Humanitarian Data Exchange, 2017). The survey asked individuals about preventative hygiene and the spread of EVD (Humanitarian Data Exchange, 2017). Through this survey, a gap in the literature was addressed. Specifically, I used these data to examine whether or not there are differences by sociodemographic groups in Monrovia, Liberia in the uptake of these preventative hygiene techniques and general understanding about EVD at the beginning of the EVD outbreak.

In this section, I will provide an outline of the research design and data collection methodology. This will involve the data collection process, design rationale, and instrumentation. I will also address possible ethical concerns and threats to validity. I will explain how these concerns will be addressed, where applicable. Finally, I will summarize what will be done to analyze the data in the next section.

Research Design and Rationale

The purpose of the 2014 primary study was to perform a population based cross-sectional survey that explored EVD knowledge among individuals living in Monrovia, Liberia during the 2014-2016 EVD outbreak (Humanitarian Data Exchange, 2017). A cross-sectional survey was chosen by the groups in charge of the initial project because they wanted a baseline understanding of what individuals living in the region understood

about EVD (Morse, 2015). I sought to use the data collected by the survey on hygiene and basic EVD knowledge among working adults to determine whether there is a difference in understanding among various sociodemographic groups. In this study, I used a combination of univariate, bivariate, and multivariable analysis techniques to determine which predictors have a significant effect on outcome and which did not.

Some challenges with the data did exist. Cross-sectional surveys do not investigate change over time and thus can predict only association and not causation (HHS, 2007). Another limitation of this study was the possibility of social desirability bias (Lavrakas, 2008). Individuals may have lied on the survey to appear as though they were using better hygiene practices than they really were (Lavrakas, 2008). The survey attempted to reassure respondents that all responses were anonymous and that the importance of honesty was imperative (Morse, 2015). This eliminated some of the possible respondent bias.

Methodology

Study Population

Monrovia is on the Western Atlantic coast of the African nation, Liberia (CIA, 2018). Monrovia is the capital city of Liberia and by far the largest city in the country (CIA, 2018). The population of Monrovia was estimated to be 970,000, according to the most recent census conducted in 2008 (LIS-GIS). In 2003, a civil war left Monrovia decimated (Bastian, 2014). According to the World Bank, in 2008, prior to the outbreak, there were only 50 doctors in the entire country (World Bank, 2019). In 2014, there were still too few doctors to meet the needs of the population, and thus, during the outbreak,

many hospitals were forced to close: many of the health workers had died (Bastian, 2014). By the time of the survey, efforts to stem the spread of EVD in Monrovia took on two forms: public health initiatives, with a focus on prevention, and outside aid (Bastian, 2014). Specifically, groups like the World Health Organization and Red Cross began setting up mobile ETRs or EVD treatment centers (Bastian, 2014). Additionally, these same groups used ad campaigns and community forums to spread the word about the epidemic (Bastian, 2014).

The primary survey attempted to gain an accurate representation of the entire city's population through a three-tiered sampling technique (Morse, 2015). Of the households surveyed, a total of 1,572 individuals responded to the survey (Morse, Grépin, Blair, & Tsai, 2016). Other than being an adult, there were no restrictions on respondents (Morse, 2015). Respondents were therefore a mixture of genders, ages, education levels, religions, and economic classes (Humanitarian Data Exchange, 2017). Homes where the only adult present had an active case of EVD were excluded from the data collection to protect the surveyors and because of the assumption that those seriously ill would not be able to answer the survey (Morse et al., 2016).

Sampling and Sampling Procedures

Sampling of the population took place in three unique stages in Monrovia, Liberia (Morse, 2015). Monrovia is divided into wards which are large clusters of communities similar to the American concept of counties. From these wards, 77 communities were chosen based on their population size so representation would be proportional throughout each ward (Morse, 2015). For example, a larger ward may have

ten communities chosen for sampling relevant to the ward's population size while a smaller ward may only have one community chosen for sampling (Morse, 2015). From each community, 20 households were randomly selected to participate in the study (Morse, 2015). From each household, only one adult (over the age of 18) respondent was allowed to answer the survey (Morse, 2015). If an individual was not home, another home in the sampling section was randomly chosen (Morse, et al., 2016). Overall, the participation rate was 95% (Morse, et al., 2016).

Power Analysis

From the survey, only specific questions will be used to address the research questions. Using all of the available sample taken from the 1572 participants ensures adequate power and also improves validity. A priori power analysis was conducted to determine sample size (G* Power calculator Universitaet Duesseldorf, 2010). While there are no similar studies in this population group, a medium effect size ($OR = 1.5$) was selected for regression analysis (Chen et al., 2010). The estimated sample size was 417 participants to achieve satisfactory statistical power (>0.95). Also, after the completion of the study, a post hoc power analysis was also conducted to confirm that adequate power was achieved.

Data Collection and Management

The MIT Lab of Governance designed and commissioned the project now considered part of the EVD Trust of Communication and Cooperation (Morse, 2015). MIT used Parley to conduct the door to door surveys in Monrovia, Liberia (Morse, 2015). Parley Liberia is a non-profit organization that functions outside of the Liberian

government and works on primarily social services projects (Bloomberg, 2019). Surveyors used handheld devices with Pendragon Software to conduct the surveys (Pendragon, 2019).

Pendragon Software allows users to access data that is being collected remotely via a cloud (2019). This is why the principle lab at MIT chose this software. Access to the cloud is through a secure, remotely encrypted ODBC connection (Pendragon, 2019). This prevents the data from being tampered with and protects the data from being altered by anyone outside of administrators with access to the cloud (Pendragon, 2019).

Data were reviewed at least once daily by the principle investigators to make sure the surveys were being done completely and accurately (Morse et al., 2016). Furthermore, principle investigators checked the timestamp on the surveys and made sure GPS was enabled on the hand-held devices (Morse, et al., 2016). The investigators then checked the time and GPS coordinates frequently to make sure that the individuals in the field doing the surveys were going to the correct locations (Morse et al., 2016). Individuals who conducted the surveys went through extensive training and none of the surveyors reported any negative experiences (Morse, 2015).

Data Accessibility and Permissions

MIT oversaw the development and implementation of the EVD response survey (Morse, 2015). These results were then shared with the Humanitarian Data Exchange in an attempt to share information with other organizations who may respond to the EVD crisis (2017). The Humanitarian Data Exchange is an open data sharing platform (2017).

The website was developed by the United Nations and is managed in Hague (Humanitarian Data Exchange, 2017).

Instrumentation and Operationalization

In order to decrease survey collection error, surveys were done electronically on hand-held devices (Morse, 2015). The surveyors used Pendragon Survey Software to ask respondents the questions (Morse, 2015). The survey lasted on average 45 minutes and included questions about food security, economic security, government response, EVD knowledge, and demographic characteristics (Humanitarian Data Exchange, 2017). Data were secured by not including personally identifiable information per the regulations established by the organizations collecting the data (Humanitarian Data Exchange, 2017).

Operationalization of Variables

All the predictor variables in this study were nominal (Table 2). The dependent variables are dichotomous with yes or no categories.

Table 2

Operationalization of Variables

Dependent Variable	Coding	Predictors	Coding
RQ1: Use of preventive hygiene techniques (use of chlorine, use of hand sanitizer, not shaking hands) by employed adults.	No = 0 Yes = 1 Don't know = 97 Don't want to answer this specific question: 98	Education	0-None 1-Some ABC 2-Completed ABC 3-Some junior high 4-Completed junior high 5-Some high school 6-Completed high school 7-Some university 8-Completed university

			88-Other
RQ2: Understanding of the basic nature of the EVD (common symptoms and how it's spread) by employed adults.	No = 0 Yes = 1 Don't know = 97	Age	18-34 = 1 35-54 = 2 55-70 = 3 70+ = 4 Do not wish to report age: 5
		Gender	Male = 0 Female = 1 Other = 2
		Occupation	0-None 1-Professional/technical 2-Clerical 3-Sales and services 4-Skilled manual 5-Unskilled manual 6-Domestic service 7-Agriculture 88-Other

Data were downloaded from the Humanitarian Data Exchange as an Excel worksheet. The Humanitarian Data Exchange is an open platform for sharing data that may be helpful to other organizations during a crisis (2017). Data analysis of the Excel worksheet was accomplished using the IBM Statistical Package for Social Sciences also known as SPSS (IBM, 2019). Data were cleaned prior to publication for any outliers or duplicate cases by the investigators (Morse, 2015). According to the website, there is a review committee that ensures submissions were collected ethically and do not disclose personally identifiable information (Humanitarian Data Exchange, 2017).

Data analysis methods were chosen based on the type of data collected (quantitative). Descriptive statistics were used to examine each of the two dependent

variables against all of the independent variables (age, gender, education, and occupation). Univariate analysis included frequency displayed as percentage of each of the demographic response categories. Further, multivariable analysis (binomial regression) was applied to test the association between the sociodemographic predictors and the two outcome variables. A result was considered statistically significant with a $p \leq .05$.

Threats to Validity

Door to door surveys can offer a unique insight into the thoughts and problems being faced by a population at a given moment in time (Morse, 2015). However, cross sectional surveys can also have a negative impact on validity (HHS, 2007). Limitations of this cross-sectional survey include the missing data of the homes skipped for active EVD cases and possible inaccurate reporting. Limitations of cross-sectional surveys in general is that they only allow for a glimpse of an issue over a distinct period of time (HHS, 2007). This means that only association and not causation can be determined (HHS, 2007).

Surveyors were told to randomly pick 20 homes within each designated zone but to skip any home with someone actively infected with EVD (Humanitarian Data Exchange, 2017). If someone was not home, surveyors went to the next home and so on as long as they remained in the pre-designated sample zone (Morse, 2015). As a result, there was an over 95% response rate (Morse, 2015). The surveys collected were completely finished so there was no incomplete or missing data within the surveys analyzed (Humanitarian Data Exchange, 2017). Accurate reporting was confirmed as

much as possible by the investigators by making the surveys electronic, monitoring survey data entry multiple times a day, ensuring the data collected correlated with the sampling plan geographically by having GPS on the survey devices, and by frequently communicating with the surveyors who also underwent extensive training to prevent error (Morse et al., 2016).

External Validity

One common threat to external validity includes selection bias (Alexander, Lopes, Ricchetti-Mastersson, & Yeatts, 2013). In this research, the primary investigators ensured that the population surveyed was a proportional representation of the population of each community (Morse, 2015). Additionally, they ensured that the homes chosen for surveys were random with the one exception of homes where the only adult had an active case of EVD were avoided (Morse et al., 2016). This was a necessary step to protect the surveyors (Morse et al., 2016). Additionally, individuals with EVD were often unable to answer a survey because they were so ill.

External validity was also limited because Liberia has had unique issues historically that made the country even more unstable entering into this crisis (Bastian, 2014). A civil war which ended in 2003 saw the death of over 250, 000 Liberian citizens (CIA, 2018). The war wreaked havoc on the country's economy and health infrastructure, of which neither had fully recovered by 2014 (Bastian, 2014). The civil war and declining economy may have therefore limited the ability to generalize this study to other countries in some ways. Economically though, many other sub-Saharan African nations have a similar GDP and poor health infrastructure (CIA, 2018). Additionally, Monrovia may

face another epidemic or other urban areas within Liberia may face an epidemic of similar nature and thus the benefits of this research are still important (WHO, 2018).

Internal Validity

Instrumentation was the primary internal validity concern entering into the primary data collection. To alleviate user error, an electronic version was made (Morse, 2015). No surveyors reported experiencing difficulty using the program (Morse, et al., 2016). Investigators monitored data entry remotely through the day to make sure the data was being collected correctly (Morse et al., 2016).

Furthermore, there was no evidence of any historical events that could have affected internal validity during the time frame samples were collected, though it took a month to get all of the over 1,000 surveys completed (Morse et al., 2016). It is possible that over a month an individual could learn more about EVD and preventive hygiene. Therefore, hypothetically, in December someone may answer the questions differently compared to if they had been surveyed later in January. Overall, though, a month was the shortest feasible amount of time possible to collect the data and each community was completed on the same day to ensure consistency at least among that cluster of respondents (Morse et al., 2016).

Ethical Procedures

For the primary study, the group that originally conducted the research at MIT obtained approval from the IRB at MIT (Morse et al., 2016). In Liberia, approval for conducting the survey was obtained through the Peacebuilding Office at the Ministry of Internal Affairs (Morse et al., 2016). An informed consent was obtained from everyone

who participated in the survey (Morse et al., 2016). The Humanitarian Data Exchange where the data are publicly published also has a rigorous ethics process prior to allowing a source to publish data on the site (2017). As a part of the United Nations Secretariat, The Humanitarian Data Exchange ensures that personally identifiable information is never published (2017). The site has an internal review process to make sure such sensitive data is never shared (Humanitarian Data Exchange, 2017). Additionally, the site has a way for viewers and publishers to report data that is suspected to be unethical (Humanitarian Data Exchange, 2017). For the secondary data study, the Walden University IRB approval was obtained prior to analyzing the data.

Ethical Considerations

One ethical consideration was privacy of the population being surveyed. Individuals were promised anonymity in the survey (Morse, 2015). In order to ensure this, the surveyors did not collect names or identifiable information (Humanitarian Data Exchange, 2017). Instead respondents were given a number to symbolize their response (Humanitarian Data Exchange, 2017). Omitting names prevents the data collected from being traced to an individual and eliminates concerns about identity protection.

Summary and Transition

In this section, I outlined my research design and rationale. I explored the instrumentalization used to collect the primary data and what will be done to analyze the data in this project. I overviewed the operationalization of variables that I will be using to perform my statistical analysis and then offered a plan for that analysis using univariate

and multivariate analysis techniques. In Section 3, I will report and display the results of my SPSS analyses.

Section 3: Presentation of the Results and Findings

The purpose of this study was to determine if there was a significant difference in EVD knowledge and prevention among different demographic groups of employed adults in Monrovia, Liberia, during the 2014-2016 EVD epidemic.Age, education level, gender, occupation, religion, and ward were chosen from the data source for further investigation as possible predictors of EVD understanding and preventative practices.

The study's research questions were as follows:

1. Is there an association between socioeconomic and demographic factors (education, age, gender, ward, religion, and occupation) and frequency of employed adults who report the use of preventative hygiene practices (use of hand sanitizer and bleach) in Monrovia, Liberia?
2. Is there an association between socioeconomic and demographic factors (education, age, gender, ward, religion, and occupation) and frequency of employed adults who report understanding the basic nature of the EVD (common symptoms and how it is spread) in Monrovia, Liberia?

This section includes a description of the data that were collected for analysis, and how the data were cleaned from a larger survey, leaving only the statistics necessary for this research's purpose. From the final data set, secondary analysis was conducted using SPSS v. 25 software to produce descriptive statistics, chi-square analyses, and multivariable analyses. Finally, this section will be summarized and a transition to section 4 will be provided.

Description of Data Abstracted for Analysis

The primary data were derived from a survey conducted by MIT in 2015, which was then published on the public data forum, the Humanitarian Data Exchange in 2017. The survey was collected in Monrovia, but not by MIT researchers. Instead, they hired an agency in Monrovia to use door to door electronic surveys that uploaded results to a cloud managed remotely in real time by the MIT group. MIT made efforts (seen in Section 2 under "Sampling and Sampling Procedures") to ensure that the survey questions were written to be widely inclusive of the current EVD situation in the city. The primary researchers also mapped the city in a way that would ensure equitable survey representation of the citizens in the various wards, and they thoroughly trained those collecting the survey data to decrease field-related errors. This yielded a 95% overall survey participation rate.

Survey restrictions for participation were minimal and included the following: respondents had to be over the age of 18, the only representative of their household taking the survey, and had to be asymptomatic for the surveyor's protection. Those surveyed were asked their age, gender, occupation, ward of residence, religion, and education level in addition to EVD-related questions. For more detail on data collection methods, see Section 2.

Data Preparation

Data analysis began after approval from the Walden University Institution Review Board (Approval No. 12-13-19-0608067). These data had already been deidentified by the primary data collectors. To begin analysis though, the data had to be further refined.

The survey utilized in this study included multiple questions that covered the current state of EVD progression in Monrovia at the time the survey was conducted. Many of the questions and answers were not necessary for inclusion in this research such as political and personal viewpoints. Certain assessment questions and categories were therefore excluded in order to narrow the focus of the project to address the research questions specifically. Other individual survey questions were grouped together into one question so more meaningful analysis could be performed.

The following survey questions were combined for the category, "EVD knowledge":

- Understanding of symptoms/ signs of EVD
- Awareness of how EVD is transmitted
- General knowledge about the virus

The following survey questions were combined into the category, "EVD prevention":

- Use of a bucket with bleach before entering the home
- Use of hand sanitizer

According to the inclusion criteria, the number of cases in the final dataset was 1334. The data analysis was performed by doing descriptive statistics of all variables of the dataset, chi- square analysis between each predictor and the dependent variables, and multivariable analysis.

Descriptive Statistics

First, descriptive statistics were conducted on both the dependent and independent variables. Age was converted to categorical from numerical, and thus all data was categorical in nature. The descriptive statistics table 3 below shows the number and percent of employed adults per variable category for 1334 collected survey responses.

Table 3

Descriptive Statistics of the EVD Monrovia Study Sample (N = 1334)

Variable	Employed Adults	
	N	%
Ward		
New Kru Town	103	7.8
Congo Town	46	3.5
Paynesville	414	31.3
Gardnersnesville	93	7.0
New George	81	6.1
Bardensville	35	2.6
Caldwell	58	4.4
Logan Town	50	3.8
Clara Town	72	5.4
West Point	79	6.0
Sonwein	53	4.0
Slipway	66	5.0
Sinkor	53	4.0
Lakpazee	55	4.2
Old Road	64	4.8
Gender		
Male	625	46.9
Female	709	53.1
Education		
None	158	12.0
Some completed-abc	130	9.9
Some completed-junior high	210	15.9
Some completed-high school	559	42.4

Some completed-university	260	19.7
Religion		
Christian	1193	89.4
Muslim	133	10.0
Other	8	6.0
Age		
18-34	639	47.9
35-54	570	42.7
>54	125	9.4
Occupation		
Professional-clerical	225	16.8
Manual	411	30.6
Sales-services	538	40.1
Other	168	12.5
Bucket Use		
No	299	22.4
Yes	1035	77.6
Sanitizer Use		
No	752	56.4
Yes	582	43.6
How you get EVD		
Aware of how you get EVD	1230	91.7
Do not know how you get it	112	8.3
Symptoms/ signs		
Aware of symptoms/ signs	1271	94.7
Do not know symptoms/ signs	71	5.3
Knowledge		
Low knowledge	911	67.9
High knowledge	431	32.1

Since the data were categorical, it was necessary to display frequency (labeled *N*) of the individual survey responses and valid percent of the responses as well. Valid percent figures will be designated with a % after them in the following breakdown of results. All variables had 1334 responses with no missing data included.

Notable results of the descriptive statistics included that most participants had a high school or college degree, were Christian, lived in Paynesville, and worked in sales-services or manual labor. Additionally, there were more individuals in the 18- 54 age categories.

Several facts may contribute to the data seen above. For age, a civil war in the early 2000s had a high death tole (Bastian, 2014). Many in the 18-34 category would have been too young to fight. The next age groups would have likely seen the most fatalities.

For ward, Paynesville had the most residents. Paynesville is a large suburb, larger than Monrovia city itself, that expands from a busy market area. Markets are essential to the Liberian economy (CIA, 2018). This combined with the large geographic area of Paynesville contribute to its higher population. Individuals from this survey primarily work in sales- service and manual labor positions. According to the CIA World Fact Book, mining and agriculture are the primary occupations in Liberia which would be classified as manual positions (2018). Within agriculture, some who sell their goods may have selected that on the survey response as well. Markets are common in Liberia where agricultural products, manmade goods, and meats are sold (CIA, 2018).

Within the gender category, the frequency was slightly skewed towards females who accounted for 53.1% of the population. The CIA World Fact Book says that maternal mortality is a serious issue in Liberia, and that female genital cutting is putting female lives at risk (2018). While these facts would suggest there should be fewer women

than men, the Fact Book also notes these issues are more prevalent among tribes and in rural settings (CIA, 2018). This study was set in Monrovia, an urban setting.

In the religion category, 1193 reported to be Christian (89.4%), 133 Muslim (10%), and 8 other (6.0%). In cities like Monrovia, tribal cultures are becoming scarcer and are often only seen in outlying areas of Liberia. Traditional burial practices are a high-risk activity for EVD transmission (CDC, 2018).

Within the research question related to preventative hygiene, respondents were more likely to use buckets. However, slightly less people used hand sanitizer than those who did not.

Within the research question pertaining to overall understanding of EVD, most respondents were aware of how you get EVD, the signs and symptoms of EVD, and overall knowledge.

Bivariate Analysis

This phase of analysis utilized the chi-square test and Cramer's *V* measure for effect. Chi-square tests are used with categorical data sets to determine if two variables in the same population are related. Chi-square tests examine independence between the observed and expected data, and for this research, the tests were held to a *p* value at 0.05. Cramer's *V* was included when an association was found through the chi-square tests to demonstrate the strength of the association.

This research examined five dependent variables and six independent variables. To make the data more user friendly, all dependent variables were combined under each independent variable creating 6 total tables instead of several. All independent variables

and dependent variables were not further combined into one table because that table would appear too congested and thus would not be easy to read. The following tables show the combined chi-square results with Cramer's *V* included.

Table 4 displays the results for the association between age, preventative hygiene practices, and understanding EVD.

Table 4

Bivariate analysis (chi-square test) between age and preventative hygiene practices and understanding of EVD (*N = 1326).*

	Age						
Dependent Variables	18-34 years N (%)	35-54 years N (%)	>54 years N (%)	Total	X^2	*P*	Cramer's *V*
Total	636	565	125	1326			
Bucket Use					4.351	.114	-
No	156 (52.5)	120 (40.4)	21 (7.1)	297			
Yes	480 (46.6)	445 (43.2)	104(10.1)	1029			
Sanitizer Use					1.653	.438	-
No	364 (48.7)	308 (41.2)	75 (10.0)	747			
Yes	272 (47.0)	257 (44.4)	50 (8.6)	579			
Total	639	570	125	1334			
How you get EVD					.809	.667	-
Aware of how you get EVD	588 (48.1)	523 (42.8)	112 (9.2)	1223			
Do not know how you get it	51 (45.9)	47 (42.3)	13 (11.7)	111			
EVD Symptoms/ Signs					1.004	.605	-
Aware of symptoms/ signs	607 (48.1)	540 (42.8)	116 (9.2)	1263			
Do not know symptoms/ signs	32 (45.1)	30 (42.3)	9 (12.7)	71			
EVD Knowledge					.733	.693	-

Low knowledge	430 (47.5)	387 (42.7)	89 (9.8)	906
High knowledge	209 (48.8)	183 (42.8)	36 (8.4)	428

Among those who did not use a bucket with bleach, 52.5% were 18-34 years old, 40.4% were 35-54 years old, and 7.1% older than 54 years. A sentence can't start with a number, unless it's spelled out 46.6% of 18-34 years old, 43.2% of 35-54 years old, and 10.1% of greater than 54 years old used buckets with bleach to clean. According to the chi-square test, with a X^2 value of 4.351 and p value of .114, there was no significant association found between age and bucket use.

Among hand sanitizer use, 48.7% of 18-34 years old, 41.2% of 35-54 year olds, and 10% of those older than 54 years did not use hand sanitizer. Forty-seven percent of 18-34 year-olds, 44.4% of 35-54 year-olds, and 8.6% of greater than 54 years old used hand sanitizer. Using the chi-square test to examine the relationship between sanitizer use and age, with a X^2 value of 1.653 and p value of .438, there was no significant difference.

For the age category, 48.1% of 18- 34 year-olds, 42.8% of 35-54 year-olds, and 9.2% of > 54 year-olds, were aware of how you get EVD. For the next question, 45.9% of the 18-34 age category, 42.3% of 35-54 year-olds, and 11.7% of > 54 year-olds were unaware of how you get EVD. According to the chi-square of association between how you get EVD and age, with a X^2 value of .809 and p value of .667, there was no significant difference.

For those who understood the signs and symptoms of EVD, 48.1% of 18-34 year-olds, 42.8% of 35-54 year-olds, and 9.2% of > 54 years were aware of the signs and

symptoms. Next, for 18-34 year-olds 45.1%, 42.3% of 35-54 year-olds, and 12.7% of > 54 year-olds were unaware. According to the chi-square test, with a X^2 value of 1.004 and *p* value of .605,, there was no significant difference.

Results for the last dependent variable tested for the independent variable age in bivariate analysis, showed that 47.5% of 18-34 year-olds, 42.7% of 35-54 year-olds, and 9.8% of > 54 year-olds, have a low level of knowledge about EVD. The next result showed, 48.8% of the 18-34 age category, 42.8% of 35-54 year-olds, and 8.4% of > 54 year-olds, have high knowledge of EVD. According to the chi-square test, these differences were not significant with a X^2 value of .773 and *p* value of .693.

Table 5 displays the results for the association between education and preventative hygiene practices, and understanding EVD.

Table 5

Bivariate analysis (chi-square test) between education and preventative hygiene practices and understanding of EVD (N = 1326).

	Education								
Dependent Variables	0 None N (%)	Some completed ABC N (%)	Some completed junior high N (%)	Some completed high school N (%)	Some completed university N (%)	Total	X^2	*P*	Cramer's *V*
Total	157	130	209	553	260	1309			
Bucket Use							24.395	.000	.137
No	37 (12.6)	46 (15.7)	54 (18.4)	119 (40.6)	37 (12.6)	293			
Yes	120 (9.2)	84 (8.3)	155 (11.8)	434 (42.7)	223 (17.0)	1016			
Sanitizer Use							68.484	.000	.229

No	111 (15.0)	99 (13.4)	133 (18.0)	291 (39.4)	105 (14.2)	739			
Yes	46 (8.1)	31 (5.4)	76 (13.3)	262 (46.0)	155 (27.2)	570			
Total	158	130	210	559	260	1317			
How you get EVD							55.704	.000	.206
Aware of how you get EVD	135 (11.2)	104 (8.6)	187 (15.5)	526 (43.5)	257 (21.3)	1209			
Do not know how you get it	23 (21.3)	26 (24.1)	23 (21.3)	33 (30.6)	3 (2.8)	108			
EVD Symptoms/ Signs							49.912	.000	.195
Aware of symptoms/ signs	138 (11.0)	114 (9.1)	196 (15.7)	542 (43.4)	259 (20.7)	1249			
Do not know symptoms/ signs	20 (29.4)	16 (23.5)	14 (20.6)	17 (25.0)	1 (1.5)	68			
EVD Knowledge							85.911	.000	.255
Low knowledge	124 (13.8)	107 (11.9)	171 (19.0)	372 (41.4)	125 (13.9)	899		.	
High knowledge	34 (8.1)	23 (5.5)	39 (9.3)	187 (44.7)	135 (32.3)	418			

The next independent variable explored was education. This was broken into no education, some completed ABC (elementary school), some completed junior high, some completed high school, and some completed university. According to the results, 12.6% of those not using buckets had no education, 15.7% ABC, 18.4% junior high, 40.6% high school, and 12.6% university. On the other hand, 9.2% of those using buckets had no education, 8.3% ABC, 11.8% junior high, 42.7% high school, and 17% university chose

to use buckets. The chi-square result showed a X^2 value of 24.395 and $p< .0001$. With p below .05 and Cramer's V at .137 (small effect size) there was a significant association between bucket use and education level thus rejecting the null hypothesis and accepting the alternative. This association is shown through the statistics to be an increase in bucket use as education levels increase, at least until the high school level.

Regarding hand sanitizer, 15% of those not using it had no education, 13.4% ABC, 18% junior high, 39.4% high school, and 14.2% university. On the contrary, 8.1% of those using hand sanitizer had no education, 5.4% ABC, 13.3% junior high, 46% high school, and 27.2% university. The chi-square result showed a X^2 value of 64.484 5 and $p< .0001$. With p value below .05 and Cramer's V at .229 (small effect size) there was a significant association between hand sanitizer use and education level thus rejecting the null hypothesis and accepting the alternative. This association is shown through the statistics to be an increase in hand sanitizer use as education levels increase.

For participants having individual awareness about contracting EVD, 11.2% had no education, 8.6% ABC, 15.5% junior high, 43.5% high school, and 21.3% university. Those unaware included 21.3% with no education, 24.1% ABC, 21.3% junior high, 30.6% high school, and 2.8% university. There was an increase in awareness of how you get EVD as education levels increase. The chi-square test showed a X^2 value of 55.704 and $p<.0001$. Cramer's $V = .195$ (small effect size) thus interpreted that this increase in awareness with education level is significant, and the null hypothesis can be rejected.

The next dependent variable examined with education was awareness of EVD signs and symptoms; 11% of those of no education, 9.1% of ABC, 15.7% of junior high,

43.4% of high school, and 20.7% of university were aware of the signs and symptoms. The dispersal of percentages among those unaware of the symptoms and sign of EVD per education group were as follows: 29.4% with no education, 23.5% of ABC, 20.6% of junior high, 25% of high school, and 1.5% of university. This showed an increase in awareness with some education levels and a significant difference demonstrated by chi-square results that included a X^2 value = 49.912, p value<.0001, and a Cramer's V = .195 (small effect size). The null hypothesis can be rejected in favor of the alternative hypothesis that there is a significant difference among education levels and EVD signs and symptoms.

For overall knowledge of EVD, 13.8% with no education, 11.9% of ABC, 19% of junior high, 41.4% of high school and 13.9% of university had low knowledge. For overall high knowledge of EVD among education groups the results were as follows: 8.1% with no education, 5.5% ABC, 9.3% junior high, 44.7% high school, and 32.3% university. X^2 = 85.911, p<.0001, and Cramer's V = .255 (small effect size) for these tests therefore showing a significant difference between the two categories. Knowledge increased with education levels which allow rejection of the null hypothesis.

Table 6 displays the results for the association between gender and preventative hygiene practices, and understanding EVD.

Table 6

Bivariate analysis (chi-square test) between gender and preventative hygiene practices and understanding of EVD (N = 1326).

Dependent Variables	Gender		Total	X^2	*P*	Cramer's *V*
	Male N (%)	Female N (%)				
Total	622	704	1326			
Bucket Use				3.090	.079	-
No	126 (42.4)	171 (57.6)	297			
Yes	496 (48.2)	533 (51.8)	1029			
Sanitizer Use				16.313	.000	.111
No	314 (42.0)	433 (58)	747 9			
Yes	308 (53.2)	271 (46.8)	579			
Total	625	709	1334			
How you get EVD				14.254	.000	.103
Aware of how you get EVD	592 (48.4)	631 (51.6)	1223			
Do not know how you get it	33 (29.7)	78 (70.3)	111			
EVD Symptoms/ Signs				8.986	.003	.082
Aware of symptoms/ signs	604 (47.8)	659 (52.2)	1263			
Do not know symptoms/ signs	21 (29.6)	50 (70.4)	71			
EVD Knowledge				26.113	.000	.140
Low knowledge	381 (42.1)	525 (57.9)	906		.	
High knowledge	244 (57.0)	184 (43.0)	428			

The third independent variable examined for association was gender. The male population had 42.4% of respondents and 57.6% of females did not use buckets. Further,

48.2% did use buckets. The chi-square results yielded a X^2 value of 3.090 and p value of .079. The value.079 is higher than the threshold for significance of .05 thus the null hypothesis is accepted.

For the hand sanitizer category, 42% of males and 58% of females did not use hand sanitizer. 53.2% of males did use hand sanitizer while 46.8% of females did. The chi-square test for independence resulted in a $X^2 = 16.313$, a $p<.0001$, and a Cramer's $V = .111$ (small effect size). There was a significant difference (more males used hand sanitizer than females) thus the null hypothesis is rejected.

Next, 48.4% of males and 51.6% of females were aware of how you get EVD. However, 29.7% of males and 70.3% of females were not aware of how you get EVD. Chi-square testing revealed an X^2 of 14.254, a p value<.0001, and Cramer's V = .103. Males were more likely to know how you get EVD than women and this result was significant.

For the signs and symptoms variable, 47.8% of males and 52.2% of females were aware of the signs and symptoms of EVD, but fewer males (29.6%) and 70.4% of females did not know the signs and symptoms of EVD. The chi-square test gave a X^2 of 8.986, a $p = .003$. Additionally, Cramer's $V = .082$ (small effect size). These results showed that males were aware of the signs and symptoms of EVD significantly more than women.

Finally, 42.1% of males and 57.9% of females had low knowledge of EVD while 57% of males and 43% of females had high knowledge of EVD. Males knew more than

women in this category, and chi-square testing revealed this difference was significant ($X^2 = 26.113$, $p<.0001$ and Cramer's $V = .140$).

Table 7 displays the results for the association between occupation and preventative hygiene practices, and understanding EVD.

Table 7

Bivariate analysis (chi-square test) between occupation and preventative hygiene practices and understanding of EVD (N = 1326).

	Occupation							
Dependent Variables	Professional-clerical N (%)	Manual N (%)	Sales-services (%)	Other N (%)	Total	X^2	*P*	Cramer's *V*
Total	225	407	535	167	1334			
Bucket Use						14.917	.002	.106
No	32 (10.7)	84 (28.1)	141 (47.2)	42 (14.0)	299			
Yes	193 (18.6)	323 (31.2)	394 (38.1)	125 (12.1)	1035			
Sanitizer Use						26.515	.000	.141
No	97 (12.9)	229 (30.5)	312 (41.5)	114 (15.2)	752			
Yes	128 (22.0)	178 (30.6)	223 (38.3)	53 (9.1)	582			
Total	225	411	538	168	1342			
How you get EVD						26.175	.000	.140
Aware of how you get EVD	216 (17.6)	386 (31.4)	489 (39.8)	139 (11.3)	1230			
Do not know how you get it	9 (8.0)	25 (22.3)	49 (43.8)	29 (25.9)	112			
EVD Symptoms/ Signs						23.766	.000	.133
Aware of symptoms/ signs	222 (17.5)	395 (31.1)	506 (39.8)	148 (11.6)	1271			

Do not know symptoms/ signs	3 (4.2)	16 (22.5)	32 (45.1)	20 (28.2)	71			
EVD Knowledge						9.600	.022	.085
Low knowledge	133 (14.6)	287 (31.5)	373 (40.9)	118 (13.0)	911		.	
High knowledge	92 (21.3)	124 (28.8)	165 (38.3)	50 (11.6)	431			

Occupation was the next independent variable analyzed. For bucket use, 10.7% of professional-clerical, 28.1% of manual professions, 47.2% of sales services, and 14% of other did not use buckets. 18.6% of professional-clerical, 31.2% of manual, 38.1% of sales-services, and 12.1% of other used buckets. The chi-square test yielded a $X^2 = 14.917$, $p = .002$, and Cramer's $V = .106$. There is a significant association between bucket use and occupation. The participants who were more likely to use buckets included the professional and manual job groups.

Next, 12.9% of professional-clerical, 30.5% of manual, 41.5% of sales services, and 15.2% of other jobs did not use hand sanitizer. 22% of professional clerical, 30.6% of manual, 38.3% of sales services and 9.1% of other did use hand sanitizer. Significantly more professional clerical workers and manual workers used hand sanitizer ($X^2 = 26.515$, a p value<.0001, and a Cramer's $V = .141$-small effect size).

For those aware of how you get EVD, 17.6% of professional clerical, 31.4% of manual, 39.8% of sales services, and 11.3% of others fell into the awareness category. The lack of awareness category included 8.0% of professional clerical, 22.3% of manual laborers, 43.8% of sales and services, and 25.9% of other. Chi-square analysis yielded a X^2 of 26.175, a $p< .0001$, and a Cramer's $V = .140$ (small effect size). A significant

higher amount of higher awareness was found among professional clerical workers and manual workers.

For the next variable, 17.5% of professional clerical, 31.1% of manual, 39.8% of sales services, and 11.6% of other reported knowing the signs and symptoms of EVD. 4.2% of professional clerical, 22.5% of manual, 45.1% of sales services, and 28.2% of other did not know any of the signs or symptoms of EVD. Chi-square showed a significant with a difference between professional clerical and manual having higher awareness than sales service or other ($X^2 = 23.766$, $p < .0001$, and Cramer's $V = .133$-small effect size).

Finally, 14.6% of professional clerical, 31.5% of manual, 40.9% of sales services, and 13% of others had low knowledge of EVD. 21.3%. of professional clerical, 28.8% of manual, 38.3% of sales services, and 11.6% of other had high knowledge of EVD. This too was significant as found by chi-square testing, although with a very small effect size ($X^2 = 9.6$, $p = .022$, and Cramer's $V = .085$).

Table 8 displays the results for the association between religion and preventative hygiene practices, and understanding EVD.

Table 8

Bivariate analysis (chi-square test) between religion and preventative hygiene practices and understanding of EVD (N = 1326).

	Religion						
Dependent Variables	Christian N (%)	Muslim N (%)	Other N (%)	Total	X^2	*P*	Cramer's *V*
Total	1186	132	8	1326			
Bucket Use					.345	.842	-
No	268 (90.2)	27 (9.1)	2 (0.7)	297			
Yes	918 (89.2)	105 (10.2)	6 (0.6)	1029			
Sanitizer Use					1.307	.520	-
No	669 (89.6)	72 (9.6)	6 (0.8)	747			
Yes	517 (89.3)	60 (10.4)	2 (0.3)	579			
Total	1193	133	8	1334			
How you get EVD					1.112	.573	-
Aware of how you get EVD	1095 (89.5)	120 (9.8)	8 (0.7)	1223			
Do not know how you get it	98 (88.3)	13 (11.7)	0 (0.0)	111			
EVD Symptoms/ Signs					.455	.797	-
Aware of symptoms/ signs	1129 (89.4)	126 (10.0)	8 (0.6)	1263			
Do not know symptoms/ signs	64 (90.1)	7 (9.9)	0 (0.0)	71			
EVD Knowledge					4.131	.127	-
Low knowledge	805 (88.9)	93 (10.3)	8 (0.9)	906		.	
High knowledge	388 (90.7)	40 (9.3)	0 (0.0)	428			

Religion was also examined in this research as a possible predictor variable. For the individuals who did not use buckets, 90.2% were Christians did not use buckets, 9.1% Muslims, and 0.7% of other religions. Similarly, individuals who used buckets were

89.2% Christians, 10.2% Muslims, and 0.6% of other religions. Thus, there was no significant difference in the association between religion and bucket use (X^2 = .345 and p = .842).

There was also no significant difference between religion and use of hand sanitizer (X^2 of 1.307 and a p of .520); 89.6% of Christians did not use hand sanitizer, 9.6% of Muslims did not, and neither did 0.8% of other religions. However, 89.3% of Christians used hand sanitizer, 10.4% of Muslims used hand sanitizer, and 0.3% of others used hand sanitizer.

Further, the participants who were aware of how you get EVD were 89.5% Christians, 9.8% Muslims, and 0.7% of others. 88.3% Christians, 11.7% Muslims, and 0% of other religions. There was no significant difference between religion and awareness of how you get EVD (X^2 of 1.112 and a p = .573).

Within the signs and symptoms category, 89.4% Christians were aware of the signs and symptoms, 10% Muslims and 0.6% of others. Among those not aware of the signs and symptoms, 90.1% were Christians and 9.9% were Muslims. Thus, there was no significant association between religion and awareness of EVD signs and symptoms (X^2 = .455 and p value = .797).

For overall knowledge of EVD, 88.9% of Christians, 10.3% of Muslims, and 0.9% of other religions had low knowledge. 90.7% of Christians, 9.3% of Muslims, and 0% of others had high knowledge, but these results were not significantly different (X^2 of 4.131 and p = .127).

Table 9 displays the results for the association between ward and preventative hygiene practices, and understanding EVD.

Table 9

Bivariate analysis (chi-square test) between ward and preventative hygiene practices and understanding of EVD (N = 1326).

Dependent Variables	Ward				Total	X^2	*P*	Cramer's *V*
	Z100-New KruTown N (%)	Z1000-Congo Town N (%)	Z1100-Paynesville N (%)	Z1200-Gardnersnesville N (%)				
Total	103	44	412	92				
Bucket Use								
No	18 (6.1)	2 (0.7)	101 (34.2)	27 (9.2)				
Yes	85 (8.3)	42 (4.1)	311 (30.5)	65 (6.4)				
Sanitizer Use								
No	54 (7.3)	20 (2.7)	238 (32.1)	47 (6.3)				
Yes	49 (8.6)	24 (4.2)	174 (30.4)	45 (7.9)				
Total	103	46	414	93				
How you get EVD								
Aware of how you get EVD	93 (7.7)	44 (3.6)	394 (32.6)	87 (7.2)				
Do not know how you get it	10 (8.9)	2 (1.8)	20 (17.9)	6 (5.4)				
EVD Symptoms/ Signs								
Aware of symptoms/ signs	97 (7.8)	44 (3.5)	396 (31.7)	90 (7.2)				
Do not know symptoms/ signs	6 (8.5)	2 (2.8)	18 (25.4)	3 (4.2)				
EVD Knowledge								
Low knowledge	76 (8.5)	31 (3.5)	269 (30.1)	52 (5.8)				
High knowledge	27 (6.3)	15 (3.5)	145 (34.0)	41 (9.6)				

Dependent Variables	Ward: Z1300-New George N (%)	Z1400-Bardnesville N (%)	Z1600-Caldwell N (%)	Z200-Logan Town N (%)	Total	X^2	*P*	Cramer's *V*
Total	80	35	58	50				
Bucket Use								
No	15 (5.1)	15 (5.1)	23 (7.8)	4 (1.4)				
Yes	65 (6.4)	20 (2.0)	35 (3.4)	46 (4.5)				
Sanitizer Use								
No	43 (5.8)	24 (3.2)	41 (5.5)	25 (3.4)				
Yes	37 (6.5)	11 (1.9)	17 (3.0)	25 (4.4)				
Total	81	35	58	50				
How you get EVD								
Aware of how you get EVD	72 (6.0)	33 (2.7)	50 (4.1)	40 (3.3)				
Do not know how you get it	9 (8.0)	2 (1.8)	8 (7.1)	10 (8.9)				
EVD Symptoms/ Signs								
Aware of symptoms/ signs	78 (6.2)	33 (2.6)	54 (4.3)	44 (3.5)				
Do not know symptoms/ signs	3 (4.2)	2 (2.8)	4 (5.6)	6 (8.5)				
EVD Knowledge								
Low knowledge	52 (5.8)	22 (2.5)	49 (5.5)	32 (3.6)				
High knowledge	29 (6.8)	13 (3.0)	9 (2.1)	18 (4.2)				

Dependent Variables	Ward: Z300-Clara Town = 10 N (%)	Z400-West Point = 11 N (%)	Z500-Soniwein = 12 N (%)	Z600-Slipway = 13 N (%)	Total	X^2	*P*	Cramer's *V*

Total	70	79	53	66
Bucket Use				
No	5 (1.7)	3 (1.0)	15 (5.1)	26 (8.8)
Yes	65 (6.4)	76 (7.5)	38 (3.7)	40 (3.9)
Sanitizer Use				
No	40 (5.4)	47 (6.3)	30 (4.0)	43 (5.8)
Yes	30 (5.2)	32 (5.6)	23 (4.0)	23 (4.0)
Total	72	79	53	66
How you get EVD				
Aware of how you get EVD	64 (5.3)	69 (5.7)	49 (4.0)	62 (5.1)
Do not know how you get it	8 (7.1)	10 (8.9)	4 (3.6)	4 (3.6)
EVD Symptoms/ Signs				
Aware of symptoms/ signs	67 (5.4)	77 (6.2)	50 (4.0)	63 (5.0)
Do not know symptoms/ signs	5 (7.0)	2 (2.8)	3 (4.2)	3 (4.2)
EVD Knowledge				
Low knowledge	55 (6.1)	60 (6.7)	44 (4.9)	41 (4.6)
High knowledge	17 (4.0)	19 (4.4)	9 (2.1)	25 (5.9)

	Ward						
Dependent Variables	Z700-Sinkor = 14 N (%)	Z800-Lakpazee = 15 N (%)	Z900-Old Road = 16 N (%)	Total	X^2	*P*	Cramer's *V*
Total	53	55	64	1314			
Bucket Use					78.647	.000	.245
No	8 (2.7)	15 (5.1)	18 (6.1)	295			
Yes	45 (4.4)	40 (3.9)	46 (4.5)	1019			
Sanitizer Use					26.098	.025	.141
No	18 (2.4)	34 (4.6)	37 (5.0)	741			
Yes	35 (6.1)	21 (3.7)	27 (4.7)	573			

Total	53	55	64	1322			
How you get EVD					30.228	.007	.151
Aware of how you get EVD	51 (4.2)	47 (3.9)	55 (4.5)	1210			
Do not know how you get it	2 (1.8)	8 (7.1)	9 (8.0)	112			
EVD Symptoms/ Signs					15.466	.348	-
Aware of symptoms/ signs	51 (4.1)	48 (3.8)	59 (4.7)	1251			
Do not know symptoms/ signs	2 (2.8)	7 (9.9)	5 (7.0)	71			
EVD Knowledge					33.622	.002	.159
Low knowledge	29 (3.2)	39 (4.4)	44 (4.9)	895		.	
High knowledge	24 (5.6)	16 (3.7)	20 (4.7)	427			

Finally, the wards, how the city of Monrovia is divided into communities, was tested for association with the dependent variables. First, 6.1% New Kru Town, 0.7% Congo Town, 34.2% Paynesville, 9.2% Gardnernesville, 5.1% New George, 5.1% Bardnesville, 7.8% Caldwell, 1.4% Logan Town, 1.7% Clara Town, 1% West Point, 5.1% Soniwein, 8.8% Slipway, 2.7% Sinkor, 5.1% Lakpazee, and 6.1% Old Road did not use buckets. 8.3% New Kru Town, 4.1% Congo Town, 30.5% Paynesville, 6.4% Gardnernesville, 6.4% New George, 2% Bardnesville, 3.4% Caldwell, 4.5% Logan Town, 6.4 % Clara Town, 7.5% West Point, 3.7% Soniwein, 3.9% Slipway, 4.4% Sinkor, 3.9% Lakpazee, and 4.5% Old Road did use buckets. The chi-square test resulted in $X^2 = 78.647$ and a $p<.0001$, and Cramer's $V = .245$ (small effect size). There is a statistically significant difference between ward and bucket use. Specifically, New Kru Town, Congo

Town, New George, Logan Town, Clara Town, West Point, and Sinkor all used buckets at higher rates per population size within dependent variable inquiry.

The dependent variable tested next was hand sanitizer use. For this variable, 7.3% New Kru Town, 2.7% Congo Town, 32.1% Paynesville, 6.3% Gardnernesville, 5.8% New George, 3.2% Bardnesville, 5.5% Caldwell, 3.4% Logan Town, 5.4% Clara Town, 6.3% West Point, 4% Soniwein, 5.8% Slipway, 2.4% Sinkor, 4.6% Lakpazee, and 5% Old Road did not use hand sanitizer. 8.6% New Kru Town, 4.2% Congo Town, 30.4% Paynesville, 7.9% Gardnernesville, 6.5%% New George, 1.9% Bardnesville, 3% Caldwell, 4.4% Logan Town, 5.2% Clara Town, 5.6% West Point, 4% Soniwein, 4% Slipway, 6.1% Sinkor, 3.7% Lakpazee, and 4.7% Old Road did use hand sanitizer. The chi-square test results were $X^2 = 26.098$ and $p = .025$, and Cramer's V was .141 (small effect size). There was an association found between hand sanitizer use and ward. Specifically, New Kru Town, Congo Town, Paynesville, New George, Logan Town, and Sinkor all used hand sanitizer at higher rates per population size within dependent variable inquiry.

The next variable showed that 7.7% New Kru Town, 3.6% Congo Town, 32.6% Paynesville, 7.2% Gardnernesville, 6% New George, 2.7% Bardnesville, 4.1% Caldwell, 3.3% Logan Town, 5.3% Clara Town, 5.7% West Point, 4% Soniwein, 5.1% Slipway, 4.2% Sinkor, 3.9% Lakpazee, and 4.5% Old Road reported being aware of how you get EVD. 8.9% New Kru Town, 1.8% Congo Town, 17.9% Paynesville, 5.4% Gardnernesville, 8% New George, 1.8% Bardnesville, 7.1% Caldwell, 8.9% Logan Town, 7.1% Clara Town, 8.9% West Point, 3.6% Soniwein, 3.6% Slipway, 1.8%

Sinkor, 9.9% Lakpazee, and 8% Old Road reported not being aware of how you get EVD. The chi-square test yielded a $X^2 = 30.228$, a $p = .007$, and Cramer's $V = .151$ (small effect size). Thus, there was a significant association found between EVD knowledge and ward. Specifically, Congo Town, Paynesville, Gardenrnesville, Bardnesville, Soniwein, Slipway, and Sinkor had greater awareness about contracting EVD compared to the other wards.

The following percentages per ward show how respondents to the survey reported awareness of the signs and symptoms of EVD: 7.8% New Kru Town, 3.5% Congo Town, 31.7% Paynesville, 7.2% Gardnernesville, 6.2% New George, 2.6% Bardnesville, 4.3% Caldwell, 3.5% Logan Town, 5.4% Clara Town, 6.2% West Point, 4% Soniwein, 5% Slipway, 4.1% Sinkor, 3.8% Lakpazee, and 4.7% Old Road. 8.5% New Kru Town, 2.8% Congo Town, 25.4% Paynesville, 4.2% Gardnernesville, 4.2% New George, 2.8% Bardnesville, 5.6% Caldwell, 8.5% Logan Town, 7% Clara Town, 2.8% West Point, 4.2% Soniwein, 4.2% Slipway, 2.8% Sinkor, 9.9% Lakpazee, and 7% Old Road do not know the symptoms/ signs of EVD. These differences were not statistically significant ($X^2 = 15.466$ and a $p = .348$).

Lastly, 8.5% New Kru Town, 3.5% Congo Town, 30.1% Paynesville, 5.8% Gardnernesville, 5.8% New George, 2.5% Bardnesville, 5.5% Caldwell, 3.6% Logan Town, 6.1% Clara Town, 6.7% West Point, 4.9% Soniwein, 4.6% Slipway, 3.2% Sinkor, 4.4% Lakpazee, and 4.9% Old Road had low knowledge about EVD. 6.3% New Kru Town, 3.5% Congo Town, 34% Paynesville, 9.6% Gardnernesville, 6.8% New George, 3% Bardnesville, 2.1% Caldwell, 4.2% Logan Town, 4% Clara Town, 4.4% West Point,

2.1% Soniwein, 5.9% Slipway, 5.6% Sinkor, 3.7% Lakpazee, and 4.7% Old Road had high knowledge. The chi-square test for independence yielded an X^2 of 33.622 and p value of .002, and the Cramer's $V = .159$ (small effect size). Therefore, the difference is significant, and the null hypothesis is rejected. The differences were most notable with Paynesville, Gardnernesville, New George, Bardnesville, Logan Town, Slipway, and Sinkor having more knowledge.

Multivariable Analysis

Binomial logistic regression was used for multivariable analysis. Binomial logistic regression was chosen because it can show the association between multiple independent variables and a dependent variable. Predictors occupation, education, and gender were analyzed with each dependent variable from the research questions. Table 10 answers research question 2: Is there an association between socioeconomic and demographic factors (education, age, gender, and occupation) and frequency of employed adults who report understanding the basic nature of the EVD (common symptoms and how it is spread) in Monrovia, Liberia?

Table 10.

Multivariable analysis for the dependent variable "How you get EVD" with predictors occupation, education, and gender.

						95% C.I. for OR	
	B	S.E.	Wald	*p* value	Odds ratio	Lower	Upper
Occupation (ref Professional-clerical)			17.657	.001			
Manual	-.614	.430	2.043	.153	.541	.233	1.256
Sales-services	-1.285	.306	17.654	.000	.277	.152	.504
Other	-.636	.270	5.546	.019	.529	.312	.899
Education (0-None)			30.638	.000			
ABC	2.674	.649	16.991	.000	14.500	4.066	51.712
Junior high	2.905	.652	19.842	.000	18.259	5.087	65.547
High school	2.378	.644	13.635	.000	10.786	3.052	38.116
University	1.734	.621	7.806	.005	5.662	1.678	19.107
Male vs. female	-.357	.242	2.171	.141	.700	.435	1.125
Constant	-3.617	.640	31.968	.000	.027		

The Hosmer and Lemeshow test showed the results adequately fit the data at p = .869. Additionally, according to the Nagelkerke R^2, a 13% variation in the outcome is explained by this model.

Occupation was a significant predictor of understanding how you get EVD (p = 0.001). The interpretation of the results are as follows: individuals of manual (*OR* = .541, 95% *CI* = .233-1.256), sales services (*OR* = .277, 95% *CI* = .152-.504), or other occupation (*OR* = .529, 95% *CI* = .312-.899) are less likely to understand how you get EVD, compared to professional-clerical participants.

With $p < .0001$, education is also a significant predictor of how you get EVD. All those with formal education were more likely to know more about how you get EVD than those with no formal education. Compared to no education in descending order, junior

high had the greatest level of understanding (*OR* = 18.259, 95% *CI* = 5.087-65.547) followed by ABC (*OR* = 14.5, 95% CI = 4.066-51.712), high school (OR = 10.786, 95% CI = 3.052-38.116), and university (OR = 5.662, 95% *CI* = 1.678-19.107). In summary, compared to no education, those with ABC were 14.5 times more likely to understand how you get EVD, those who finished junior high were 18.259 times more likely to know how you get EVD, those who completed high school were 10.786 times more likely than those with no education to know how you get EVD, and those who finished university were 5.662 times more likely to know how you get EVD compared to those with no formal education.

For gender, the *p* value is .141 which is above the 5% significance level. Gender is therefore, not a significant predictor of understanding how you get EVD.

Table 11 partially answers research question 2: Is there an association between socioeconomic and demographic factors (education, age, gender, and occupation) and frequency of employed adults who report understanding the basic nature of the EVD (common symptoms and how it is spread) in Monrovia, Liberia? This table shows the association between independent variables occupation, education, and gender and the dependent variable EVD knowledge.

Table 11

Multivariable analysis for the dependent variable "Knowledge" with predictors occupation, education, and gender.

						95% C.I. for OR	
	B	S.E.	Wald	*p* value	Odds ratio	Lower	Upper
Occupation (ref Professional-clerical)			3.002	.391			
Manual	-.214	.240	.797	.372	.807	.505	1.291
Sales-services	.121	.211	.328	.567	1.129	.746	1.708
Other	-.067	.206	.104	.746	.936	.625	1.400
Education (0-None)			61.680	.000			
ABC	-1.325	.248	28.633	.000	.266	.164	.432
Junior high	-1.550	.279	30.795	.000	.212	.123	.367
High school	-1.560	.232	45.302	.000	.210	.133	.331
University	-.794	.166	22.856	.000	.452	.326	.626
Male vs. female	.349	.133	6.857	.009	1.417	1.092	1.840
Constant	-.064	.230	.077	.782	.938		

The Hosmer and Lemeshow test showed the results adequately fit the data at p = .270. Additionally, according to the Nagelkerke R^2, a 9.7% variation in the outcome is explained by this model.

Occupation with a p value of .391 was not a significant predictor of EVD knowledge. With a p<.0001, education is a significant predictor of EVD knowledge. Compared to no education in descending order, university had the highest level of knowledge (*OR* = .452, 95% *CI* = .326-.626) followed by ABC (*OR* = .266, 95% *CI* = .164-.432), junior high (*OR* = .212, 95% *CI* = .123-.367), and high school (*OR* = .210, 95% *CI* = .133-.331).

For EVD knowledge among genders the *p* value is .009 thus showing a significant difference between males and females. Examination shows that with males used as the reference gender and an odds ratio of 1.417 (95% *CI* = 1.092-1.840), females are more likely to have greater knowledge about EVD.

Table 12 shows the association between sanitizer use and predictors occupation, education, and gender. This table corresponds with the first research question: Is there an association between socioeconomic and demographic factors (education, age, gender, and occupation) and frequency of employed adults who report the use of preventative hygiene practices (use of hand sanitizer and bleach) in Monrovia, Liberia?

Table 12

Multivariable analysis for the dependent variable "Sanitizer" with predictors occupation, education, and gender

	B	S.E.	Wald	*p* value	Odds ratio	95% C.I. for OR Lower	Upper
Occupation (ref Professional-clerical)			9.943	.019			
Manual	.602	.230	6.882	.009	1.827	1.165	2.865
Sales-services	.565	.202	7.826	.005	1.759	1.184	2.613
Other	.361	.197	3.371	.066	1.435	.976	2.110
Education (0-None)			43.070	.000			
ABC	-1.155	.233	24.644	.000	.315	.200	.497
Junior high	-1.367	.259	27.878	.000	.255	.153	.423
High school	-.850	.207	16.940	.000	.427	.285	.641
University	-.434	.163	7.063	.008	.648	.470	.892
Male vs. female	.156	.125	1.558	.212	1.169	.915	1.493
Constant	-.178	.223	.637	.425	.837		

The Hosmer and Lemeshow test showed the results adequately fit the data at p = .737. Further, according to the Nagelkerke R^2, 8.1% variation in the outcome is explained by this model.

Occupation was a significant predictor of hand sanitizer use among this population with a p value = .019. individuals with occupations besides professional-clerical were less likely to use hand sanitizer. Those in manual jobs were 1.827 less likely to use hand sanitizer (95% *CI* = 1.165-2.865). Individuals in sales-services used hand sanitizer 1.759 times less (95% *CI* = 1.184-2.613), and those in the other category used hand sanitizer 1.435 times less (95% *CI* = .976-2.130).

Education is a significant predictor of hand sanitizer use with p value<.0001. Increased hand sanitizer use was seen among those with formal education. The use of hand sanitizer can be seen as follows among education levels: university (*OR* = .648, 95% *CI* = .470-.892), high school (*OR* = .285-.641), ABC (*OR* = .315, 95% *CI* = .200-.497), and junior high (*OR* = .255, 95% *CI* = .153-.423).

For gender, p value = .212. Gender is not a significant predictor of hand sanitizer use.

The Table 13 demonstrates the association between occupation, education, and gender with the dependent variable signs and symptoms. Signs and symptoms was a component of the second research question looking at overall EVD knowledge among the study population.

Table 13

Multivariable analysis for the dependent variable "Signs and Symptoms" with predictors occupation, education, and gender.

	B	S.E.	Wald	*p* value	Odds ratio	95% C.I. for OR Lower	Upper
Occupation (ref Professional-clerical)			13.238	.004			
Manual	-1.276	.660	3.734	.053	.279	.076	1.018
Sales-services	-1.250	.360	12.036	.001	.287	.141	.581
Other	-.746	.323	5.331	.021	.474	.252	.893
Education (0-None)			25.401	.000			
ABC	3.447	1.053	10.722	.001	31.398	3.990	247.098
Junior high	3.233	1.063	9.243	.002	25.362	3.155	203.898
High school	2.753	1.058	6.766	.009	15.685	1.971	124.815
University	1.994	1.043	3.657	.056	7.347	.952	56.734
Male vs. female	-.245	.307	.638	.424	.783	.429	1.428
Constant	-4.511	1.050	18.475	.000	.011		

The Hosmer and Lemeshow test showed the results adequately fit the data at p = .498. Further, according to the Nagelkerke R^2, a 14.2% variation in the outcome is explained by this model.

For occupation, the p value = .004. Occupation is thus a significant predictor of understanding EVD signs and symptoms. Individuals working in professional or clerical fields were more likely to understand the signs and symptoms of EVD. This is demonstrated through the odds ratios of the other professions: other (*OR* = .474, 95% *CI* = .252-.893), sales-service (*OR* = .287, 95% *CI* = .141-.581), and manual (*OR* = .279, 95% *CI* = .076-1.018).

Education is also a significant predictor in this category with *p* value< .0001. All those with formal education were more likely to know more about EVD signs and symptoms. Specifically, those with ABC education were 31.398 times more likely to know the signs and symptoms (95% *CI* = 3.990-247.098), junior high 25.362 times more likely (95% *CI* = 3.155-203.898), high school 15.685 times (95% *CI* = 1.971-124.815), and university 7.347 times (95% *CI* = .952-56.734).

For gender, the *p* value is .424 which is above the 5% significance level. Therefore, gender is not a significant predictor of EVD sign and symptom recognition.

Bucket use was the second part of the first research question which looked at preventative hygiene use in the study population. Sown below is bucket use among working adults of the following demographics: education, occupation, and gender.

Table 14

Multivariable analysis for the dependent variable "Bucket Use" with predictors occupation, education, and gender

						95% C.I. for OR	
	B	S.E.	Wald	*p* value	Odds ratio	Lower	Upper
Occupation (ref Profesional-clerical)			7.869	.049			
Manual	.359	.279	1.657	.198	1.432	.829	2.472
Sales-services	.274	.221	1.538	.215	1.316	.853	2.030
Other	-.107	.210	.257	.612	.899	.595	1.358
Education (ref 0-None)			14.790	.005			
ABC	-.509	.278	3.350	.067	.601	.348	1.037
Junior high	-1.040	.278	13.976	.000	.353	.205	.610
High school	-.623	.255	5.988	.014	.536	.326	.883
University	-.427	.217	3.875	.049	.652	.427	.998
Males vs. Females	.081	.148	.302	.583	1.085	.811	1.450
Constant	1.589	.268	35.115	.000	4.897		

The Hosmer and Lemeshow test showed the results adequately fit the data at p = .995. Further, according to the Nagelkerke R^2, 3.7% variation in the outcome is explained by this model.

Occupation was a significant predictor of bucket use among this population with a p value = .049. Individuals with occupations besides professional-clerical were less likely to use hand sanitizer. The interpretation of the results are as follows: individuals of manual (*OR* = 1.432, 95% *CI* = .829-2.472) sales services (OR = 1.316, 95% CI = .853-2.030) or other occupation (*OR* = .899, 95% *CI* = .595-1.358) are less likely to understand how you get EVD, compared to professional-clerical participants.

Education was a significant predictor of bucket use with *p* value = .005. All education levels beyond no education had increased bucket use; in decreasing order bucket use was as follows: university (*OR* = .652, 95% *CI* = .427-.998), ABC (*OR* = .601, 95% *CI* = ..348-.1.037), high school (*OR* = .536, 95% *CI* = .326-.883), and junior high (*OR* = .353, 95% *CI* = .205-.610).

For gender, the *p* value is is .583, thus gender is not a significant predictor of bucket use.

Summary and Transition

The results of the descriptive statistics, chi-square analysis, and binomial logistic regression were presented in Section 3. These results explored the association between independent variables (age, occupation, education, ward, and religion) and preventative hygiene measures including the use of hand sanitizer and buckets with bleach. The second research question explored the association of these independent and EVD understanding as measured by overall knowledge, knowledge of the signs and symptoms, and awareness of how you get EVD.

Chi-square analysis revealed that age, ward and religion were not significant predictors of EVD understanding and preventive hygiene and were eliminated as independent variables for multivariable analysis. Based on BLR analysis, education was a significant predictor of EVD understanding for all criteria/ categories, so the first null hypothesis is rejected. Education is a significant predictor of preventative hygiene use among both criteria defined in the first hypothesis, so the null hypothesis is rejected. Gender was not a significant predictor of knowledge pertaining to how you get EVD and

signs and symptoms but was for overall knowledge with females knowing more than males. Gender was not a predictor for hand sanitizer use or bucket use. Occupation was a significant predictor for how you get EVD and signs and symptoms but not general EVD knowledge. For hypothesis two, occupation was a significant predictor of hand sanitizer use but not of bucket use.

Section 4 is next and will cover a more detailed interpretation of these findings. Also, in Section 4 the limitations, recommendations for future study, and the use of this research to promote social change will be discussed.

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

Healthcare and public health professionals are becoming increasingly concerned as EVD outbreaks over the last decade have shown rising mortality rates (CDC, 2017). The EVD outbreak of 2014-2016 caused over 11,000 deaths throughout Africa with Liberia experiencing the highest morbidity and mortality (CDC, 2017). Spread into urban centers like Monrovia, Liberia is partially responsible for this new trend (CDC, 2017). A cross-sectional survey conducted by MIT in Monrovia during the epidemic was used to explore the nature of EVD in Liberia in more detail.

Using the survey, this study explored the impact of sociodemographic and socioeconomic factors on the use of bleach and hand sanitizer and on general EVD knowledge among employed adult Monrovians, by using bivariate (chi-square) and multivariable analysis (binomial logistic regression). The survey was conducted in all 15 of Monrovia's wards. Seventy-seven communities were chosen within the wards, based on population size, and then homes were chosen randomly by the surveyors. Data were collected electronically and uploaded in real time to a cloud, where researchers could oversee its accuracy and address concerns.

A better understanding of these associations could lead to more effective preventative programming among employed adults in future outbreaks. In Section 4, these results will be discussed within the context of the literature, and recommendations for practice and future research, as well as social change implications, will be provided.

Interpretation of the Findings

Key findings of the study

According to the results of the study, occupation and education were significant predictors of hand sanitizer use, but gender was not. People working in professional-clerical jobs were more likely to use hand sanitizer compared to other occupations. Those who finished university were most likely to use hand sanitizer followed by those who finished high school, ABC, junior high, and no school.

Occupation and education were also significant predictors of bucket use. Those in professional-clerical positions were most likely to use buckets with bleach as were those with formal education. Bucket use decreased among levels of education in the following order: university, ABC, high school, junior high, and none. Therefore, occupation and education are significant predictors of use of preventative hygiene practices.

In addition, I explored the association between EVD knowledge and sociodemographic factors. The first variable, "How you get EVD," was analyzed with predictors occupation, education, and gender. Occupation and education, but not gender, were found to be significant predictors. Within occupation, those working in manual, sales-services, or "other" occupations were less likely to understand how you get EVD compared to individuals working in professional-clerical occupations. For education, those who finished junior high had the greatest level of knowledge followed by ABC, high school, university, and no formal education.

The second variable, "Knowledge," encompassed general knowledge questions about EVD. Occupation was not a significant predictor of EVD knowledge, but education and gender were. Knowledge about EVD decreased in the following order among the

categories: university, ABC, junior high, high school, and none. Females were more likely to know about EVD.

Occupation and education, but not gender, were significant predictors of understanding EVD signs and symptoms. Those working in clerical-professional fields had the highest amount of knowledge, and those with formal education were more likely to know the signs and symptoms. For education, knowledge decreased in the following order: ABC, junior high, high school, and university.

Finally, occupation and education were predictors for understanding how you get EVD and understanding of EVD signs and symptoms. For EVD knowledge, education and gender were also significant predictors.

Findings in Relation to the Literature

Research has shown that certain age groups, especially the older, are more at risk for dying or developing complications from EVD (Glynn, 2015). Older individuals are also more likely than the rest of the Liberian population to be impoverished or lack healthcare (Maharaj, 2012). These facts make age an important demographic to consider when examining the 2014-2016 EVD epidemic. Results from this study showed that age was not a significant predictor of EVD knowledge or preventative hygiene. This indicates that despite lack of adequate healthcare or finances, older are still able to practice basic EVD hygiene measures and understand general EVD knowledge.

In this study, religion was not a significant predictor of EVD knowledge or preventative hygiene. One of the highest risk activities for contracting EVD is any contact with bodily fluids including through Liberian burial practices (Pandey, Atkins,

Medlock, Wenzel, Townsend, Childs, & Galvani, 2014). Though burial ceremonies themselves may differ among religions, the Liberian burial ceremonies that increase exposure may be more cultural compared to religious as indicated by literature (CDC, 2018). Use of PPE while burying an EVD positive body and use of professional burial services should continue to be promoted indiscriminately among all religions studied: Christians, Muslims, tribal, etc. (Suwantarat & Apisarnthanarak, 2015).

Ward was not considered a significant predictor of EVD knowledge or preventative hygiene use among employed Monrovians, probably because the significant predictors found in this study (occupation, education, and gender) were more or less evenly distributed among the communities in Monrovia. Any investment into educational campaigns proposed in professional practice should thus be done throughout Monrovia and not be focused in one specific community.

Professional-clerical occupations were found to be significantly more aware of EVD signs and symptoms and how EVD is spread and were more likely to use preventative hygiene compared to other professions. This field would include healthcare workers who are known to be more at risk for contracting EVD (Suwantarat & Apisarnthanarak, 2015). Literature revealed a lack of resources including medicine and PPE likely led to increased infection rates among this field (Gee & Skovdal, 2017). However, these results show that more basic hygiene practices like hand sanitizer and bleach were being used. It is also logical that healthcare workers would have more knowledge about EVD signs and symptoms and how EVD is spread compared to other professions because of their training (Oladimeji, et al., 2015). Though this same study by

Oladimeji, et al. found that often the quality of training varied (2015). Other professional occupations may be at a similar advantage because of trainings and access to hand sanitizer or more financial means to purchase preventative hygiene measures (Doocy, & Burnham, 2006).

Other occupations may put some workers more at risk, such as miners who are exposed to bats which are known carriers of EVD (CDC, 2018). Hunters and those who sell bush meat in the markets are also more at risk for contracting EVD (CDC, 2018). It is therefore concerning that these professions are included in the group of occupations who were less likely to know how EVD is spread, the signs and symptoms of EVD, and were less likely to use preventative hygiene. Educational efforts or aide for hygiene items would be a valuable initiative among these groups (Doocy & Burnham, 2006).

For the variable education, those with formal education (ABC-university) understood more about EVD and practiced more preventative EVD hygiene measures compared to those with no formal education. Public health-based education programs have been proven to be one way to mitigate the spread of EVD (CDC, 2018). Varying levels of EVD knowledge and hygiene practice among grade levels cannot be clearly determined, but based on these results and current literature, education on EVD throughout school would likely be beneficial (CDC, 2018).

Several studies have shown differences in male vs. female hygiene practices and public health knowledge (Judah et al., 2009). This research revealed women had more general EVD knowledge compared to men, but the two genders were comparable when

looking at preventative hygiene measures, knowledge of signs and symptoms, and knowledge of how EVD is spread.

Women are traditionally the caregivers for those who are sick in the home as well as for extended family (Suwantarat & Apisarnthanarak, 2015). As the epidemic progressed, mistrust of the government and hospitals led to even more home care (Suwantarat & Apisarnthanarak, 2015). Women were considered more at risk for contracting EVD for this reason, and because they were more likely to prepare bodies for burial (Suwantarat & Apisarnthanarak, 2015). Based on this literature, females in the study population would have been most likely to have personally cared for an EVD relative or to have prepared a body for burial (Suwantarat & Apisarnthanarak, 2015). Thus, women are seeing and experiencing a side of the EVD epidemic statistically more than men which may be giving them more insight into generally what happens during EVD progression (Suwantarat & Apisarnthanarak, 2015). Those who care for the sick are also more likely to take precautions (if possible), which could include seeking additional educational (Gatherer, 2014).

Interpretation of Findings in the Context of the Theoretical Framework

The Theory of Reasoned Action/ Planned Behavior examines the relationship between attitudes and behaviors (Bensley & Brookins-Fisher, 2003). For this study, the behaviors being analyzed were the use of preventative hygiene and learning/remembering knowledge about EVD. Contracting EVD is the potential negative outcome of not taking these measures. This analysis assumes that people want to prevent EVD infection. There are several reasons individuals would be motivated to prevent EVD infection including

working to provide for themselves and their families, serving as caregivers, and because they witnessed the personal and economic effects from previous epidemics (Suwantarat & Apisarnthanarak, 2015).

Attitudes about these behaviors can be influenced by several internal and external factors including beliefs about what outcome the behavior will yield and how valuable that outcome may be (Bensley & Brookins-Fisher, 2003). In schools, consistent education may be used to reinforce the belief that learning and remembering EVD facts and using preventative hygiene will result in not getting infected, and further that not getting infected will prevent serious illness and possibly death (CDC, 2018). Kids will be more likely to practice preventative hygiene and retain knowledge if they believe that remembering the signs and symptoms of EVD, knowing about EVD, and knowing how to identify EVD prevent infection.

This research showed that individuals working in professional-clerical positions were more likely to know about EVD signs and symptoms and how EVD is spread and to practice EVD preventative hygiene. A person in healthcare may believe the hygiene measures discussed prevent EVD because they have lived experience in addition to training (CDC, 2016). This belief will lead to those in healthcare being more likely to practice these behaviors (Bensley & Brookins-Fisher, 2003). If training about preventative hygiene and the need to have EVD knowledge to reduce transmission is less among other professions or if access to preventative hygiene is less, than beliefs about their effectiveness in disease prevention may be less as well (Bensley & Brookins-Fisher, 2003).

Women serve an important role in Liberian society by functioning as caregivers, mothers, teachers, cooks, etc. (Suwantarat & Apisarnthanarak, 2015). They are essential to the running of the household and family in the Liberian culture (Suwantarat & Apisarnthanarak, 2015). Females were identified as having more EVD knowledge than men in this study population. Within the context of the TRA/ PB, women believe that having more EVD knowledge is likely to help prevent EVD infection (Bensley & Brookins-Fisher, 2003). It is unknown whether this is because of lived experience because they remembered the trauma from previous EVD outbreaks or if it is done purposefully to prevent the spread to their families after caring for a sick loved one and to protect themselves as a crucial part of the home.

Social norms also play an important role in behavioral decision making (Bensley & Brookins-Fisher, 2003). With this study, variations within different education levels offer an opportunity to look at social norms in more detail. Children will be more likely to do a desired behavior if a child believes his or her parents, teachers, and peers want them to learn more about EVD and want them to practice preventative hygiene. Parents and teachers should show children how proud they are when they practice and remember what they have learned.

People want approval from their peers, not just throughout school, but as adults too (Bensley & Brookins-Fisher, 2003). This may offer insight into the occupations where disparities were seen in EVD knowledge and preventative hygiene practices. If an individual sees his coworkers taking more precautions or believes his coworkers approve or want him/her to adopt these behaviors than they are more likely to do so themselves.

Workers were motivated to get back to work after the previous EVD epidemic caused significant job losses and economic hardship. EVD infection prevention can prevent this (CDC, 2018). Education could reinforce this as an additional benefit of EVD prevention beyond preventing serious illness (CDC, 2018). If coworkers and bosses are motivated in some way to practice these skills, then slowly everyone in the workplace will get on board. Establishing social norms may be done through training or purchasing hand sanitizer and bleach for employees as is done for healthcare workers, the population with the most knowledge of EVD and best prevention practices.

Based on cultural norms, women believe they must serve the role as the caretaker (Suwantarat & Apisarnthanarak, 2015). As such, women likely believe their family wants them to take precautions to know about EVD so they can identify the ill and to protect themselves. However, these theories do not account for other cultural or demographic motivators. Ward, for example, was a potential predictor used in this study, but it was not found to be significant (Bensley & Brookins-Fisher, 2003). On the other hand, cultural factors like traditional burials or hunting bushmeat are considered to be risk factors for infection (CDC, 2018).

Other external and internal barriers that cannot be overcome may exist as well, such as financial barriers to purchase hygiene measures, personality barriers (some people may not be influenced by social norms or have attitudes that are unchangeable by reason), some people may be afraid, some may be unable to get a professional-clerical job, and some people may lack access to education (Bensley & Brookins-Fisher, 2003). Extending education and media campaigns to all literacy levels, even those without

formal education, to all occupations, and possible government subsidizing may be options. Campaigns could also address mistrust of the government and fear of the disease so people can begin to feel in control and make more reasoned decisions.

Limitations

There are some limitations to the secondary data set which was chosen for this research. The primary investigators mitigated many potential issues with the data such as using a non-governmental agency to do the surveying, collecting data electronically for monitoring and accuracy, and mapping out the data collection strategically so an accurate representation of the population would occur. However, regardless of these measures certain challenges exist.

First, the survey was cross sectional meaning that the data collected can only demonstrate association and not necessarily causation (HHS, 2007). Cross sectional surveys like this one also only refer to a brief time period. Thus, this study may not be an accurate representation of the preventative hygiene practices used throughout the entire epidemic or the knowledge of EVD among the population for those two years. However, the data were collected at the early stages of the epidemic in Liberia and still can offer insights into the questions being posed in this research.

Additionally, there is always the possibility of field error despite safeguards. Investigators were told to report any problems, and respondents were given anonymity. Further, keeping the survey simple and electronic hopefully reduced incorrect responses.

Recommendations

Future research should explore in more detail the barriers preventing the identified populations from gaining knowledge and preventative hygiene measures. Specifically, occupation and education could be explored in this manner as the most common demographic predictors of EVD knowledge and hygiene use.

Formal education has been shown in this research to improve EVD knowledge and preventative hygiene use. Future qualitative studies and surveys among the same population surveyed previously could investigate why these individuals did not pursue higher education. Social, financial, and geographical, barriers, among others, may be identified and could be mitigated to improve access to education and thus potentially increase health literacy.

Additionally, surveys within businesses could be used to identify individuals without formal education. These surveys would need to be done in a way that employees are not embarrassed to report they lack education. Individuals identified as lacking formal education would benefit most from training. Encouraging training for anyone without formal education without specifically identifying these individuals or making the training outside of work hours, online, or in a pamphlet form might help to make the training more accessible. Literacy levels when developing programming for this would also need to be considered.

For occupation, careers other than professional-clerical occupations were found to have less knowledge of EVD signs and symptoms and how EVD is spread as well as to use EVD preventative hygiene measures less. Like education, more detailed surveys

among people who work in manual, sales-service, and other jobs may reveal why these careers are less advantaged. Financial, social, and demographic barriers should be explored here as well.

Additional survey methods could be used to offer insight into the EVD epidemic in this population. This research was limited because it was a cross sectional survey. A longitudinal study would be a better gauge of how EVD knowledge or preventative hygiene measures change over time. This type of study could measure either how people are still changing their habits since the EVD epidemic, how people are responding to different epidemics since the 2014-2016 EVD outbreak, or how these studies could be used in conjunction with new preventative educational campaigns. Post 2014-2016 EVD epidemic surveys with the same population may also garner valuable insight into how the epidemic progressed and how the research questions changed at later dates.

Other populations to study include more locations in Liberia, rural instead of urban areas, or similar urban areas in other EVD affected countries. Studying these populations will offer a broader scope for comparison and contrast. Additionally, in future research, more variables could be studied. For example, variables could be studied that are known to increase EVD spread. Future surveys could explore whether individuals who help their families with preparing bodies for traditional burial or whether individuals who consume or handle bush meat use preventative hygiene or have EVD knowledge.

Implications for Professional Practice

Many professions can benefit from the findings of this research. For example, teachers can make a difference in the future mitigation of EVD and other epidemics by

teaching children about EVD and preventative hygiene as soon as they enter primary school. Disparities were seen in knowledge and hygiene at each grade level so these lessons should be reinforced as children progress through their education. Additionally, prior to a future epidemic, I recommend that Monrovia invest in its education system and promote school enrollment to families.

Improving education rates may also improve access to job opportunities. This research revealed that those with professional-clerical jobs were more likely to understand EVD and take precautions to prevent infection. Many professional-clerical careers require formal education.

Employers of manual laborers, sales-service professionals, and others could buy hand sanitizer and bleach for their employees and offer education at staff meetings or trainings with their employees. Employers will benefit through future epidemics by being able to stay operational and profitable. Government officials who regulate businesses could also encourage these practices to reach a large portion of the population.

The final key finding was that females understood more about general EVD information than males. One recommendation would be to target this demographic group with information through public health agencies. This could be done through tailoring media pieces to males, offering community education forums or presentations for men, or targeting primarily male professions or community groups. Women could also be encouraged through the same means to teach their family members and friends what they know about EVD.

Doctors who see male patients could be a source for educating men on EVD general facts to help with that disparity. Companies who primarily employee men could also be incentivized to teach men the need for understanding EVD and preventing its spread.

If recommendations are followed, evaluation will be imperative as campaigns and programs are implemented. Focus groups, pre and post-tests, and additional surveys may offer useful guidance for programs as they go forward.

Positive Social Change

This research identified critical gaps in EVD knowledge and hygiene practice among specific population demographics of Monrovian workers. In Liberia alone, over 10,000 cases of EVD were reported with a nearly 50% mortality rate (CDC, 2018). The first positive social change that may result from this research is a decrease in mortality by improving awareness of these gaps and addressing them by employers with workplaces initiatives. Those in manual, sales-service, and other professions knew less about EVD signs and symptoms, how EVD is spread, and preventative hygiene, females knew more about EVD knowledge, and those without formal education knew less about EVD knowledge and preventative hygiene.

When mortality is reduced, more people can work which should be another motivation for employers to take the professional practice recommendations into consideration. This can also serve as further motivation for government involvement in the recommendations listed because more working adults during an epidemic means a more stable economy (Adegun, 2014). If resources for education are scarce, awareness

campaigns can be targeted to the identified professions, genders, and education levels as applicable. This will allow the funds available for prevention to go further and have a greater impact.

Formal education was identified as an important predictor of EVD knowledge and EVD preventative hygiene among working Monrovians. The government could play a pivotal role in impacting social change by encouraging formal schooling, increasing access to schooling, and through offering public health programming in schools to teach EVD knowledge and hygiene measures. Individual school systems could look at greater familial involvement in childhood education and teacher training in public health concepts to prevent EVD spread and mortality in future epidemics.

Conclusion

A survey conducted during the 2014-2016 EVD epidemic attempted to investigate what people living in the capital city of Liberia understood about EVD and what measures they were taking to prevent getting infected. These survey questions were analyzed with the sociodemographic and socioeconomic data also collected to determine if there was an association between EVD knowledge and preventative hygiene with these groups. The research only focused on working adults since 97% of the Liberian population works and this could serve as a population for targeted public health prevention initiatives if differences were found (CIA, 2018).

Analysis revealed that those working in nonprofessional-clerical occupations knew less about EVD signs and symptoms and how EVD is spread and about EVD hygiene measures, females knew more general EVD facts, and anyone with formal

education had more comprehensive EVD knowledge and practiced more preventative hygiene techniques. Therefore, these results revealed that the individual topics for which professions, which genders, and which education levels need to be addressed in future educational efforts among working Monrovians.

The 2014-2016 EVD epidemic that swept through Western Africa left a devastating impact on the lives of the survivors, the healthcare system, and on the economy. The potential for another epidemic is always looming until a cure for EVD is discovered. Prevention measures may be more effective if they are targeted to populations who understand less about EVD and are accessible to public health campaigns, i.e. individuals who are employed. Lessons learned from this research may impact public health in Liberia and reduce mortality and morbidity in future EVD epidemics.

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