Assessing the Impact of Ebola Health Campaigns in Senegal, West Africa

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Abstract

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The magnitude of the 2013-2016 West Africa Ebola outbreak demonstrates the importance of minimizing exposure risks and understanding the drivers that influence behavioral change. This study assessed the impact of multiple health visits by non-governmental organizations and the ministry of health on behavioral change in rural villages peripheral to Ebola infected zones. Randomized surveys in seven rural villages in southeastern Senegal were used to collect data on 100 adults' knowledge and response to Ebola health trainings. Individuals who experienced multiple health visits were less likely to adopt preventive behavioral changes in some regions. Locational differences affected individuals' likelihood of adopting behaviors related to hygiene and bushmeat practices. Multiple health visits were ineffective in increasing protective behavioral change. These results will assist in the assessment of the adequacy of Ebola health

campaigns and provide insight in designing future behavioral change interventions to thwart pathogen transmission and prevent future outbreaks.

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List of Abbreviations

EBOV	Ebola Virus (also known as Ebola Hemorrhagic Fever)
CHW	community health worker
NGO	non-governmental organization
MOH	ministry of health
SMS	short message service
USAID	United States Agency of International Development
WHO	World Health Organization

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1 Introduction

Since December 2013, the West African countries Guinea, Liberia and Sierra Leone have been crippled by the largest Ebola Virus (EBOV) outbreak to date. Virology investigations identified the virus as EBOV from the Filoviridae Family (formerly Zaire species), one of five species of the genus Ebolavirus. With an average 50% fatality rate in humans (but up to 90% depending on virus strain and location), EBOV has resulted in over 28,616 cases and over 11,310 deaths since 2013 (WHO, 2016). Prompted by its rapid propagation and severity, the World Health Organization (WHO) declared a public health emergency of international concern on August 8, 2014 (Chippaux, 2014, WHO 2016).

Senegal, a West African country directly bordering Guinea to the North, was one of several adjoining countries affected by the outbreak, and experienced a single imported human case. In response to the epidemic, numerous non-governmental organizations (NGOs) collaborated with Senegal's ministry of health (MOH) to promote social mobilization for EBOV prevention in regions peripheral to infected zones.

Prevention of EBOV infection can involve addressing both zoonotic and person –to-person transmission. Fruit bats from the Pteropodidae family *(Hypsignathus monstrosus, Epomops franqueti, Myonycteris torquata)* are the probable reservoir for EBOV and appear resistant to Filoviridae pathogenicity (Chippaux, 2014). The insectivorous bat *(Mops condylurus)* from the Molossidae family may also be a reservoir and contact with this species was linked to the index case in the West Africa 2013 outbreak (Pourrut et al, 2007, Saéz, et al, 2015). Researchers suspect that non-human primates, porcupines and duikers can serve as intermediate hosts (WHO, 2016). EBOV virus is initially introduced by contact with an infected wildlife species' bodily fluids and tissues (blood, secretions, organs, salvia, urine, feces or other bodily fluids). The clustering of frugivorous animals and competition for shared food sources is suspected to contribute to intraspecific disease transmission. Hunters and butchers are especially vulnerable for contracting EBOV from a scratch, bite or contact with an infected animal's tissue. Genome sequencing of EBOV in Sierra Leone and Guinea supports the hypothesis that the West African outbreak stems from a single spillover event from a wildlife source and is perpetuated by human-to-human transmission (Alexander et al, 2015). Secondary transmission often occurs during patient care, funerals or hospitalization. Such human-to-human transmission results from direct contact with broken skin, mucous membranes, bodily fluids and organs, and contributes to disease amplification. During the 2013-2016 West African outbreak, an estimated 30.7% of EBOV transmission occurred at the household level (Merler et al, 2015).

Clinical diagnosis of EBOV is often delayed due to poor specificity of symptoms, a long asymptomatic incubation period and infection-associated social stigmas. For the EBOV outbreak in West Africa the basic reproduction number (defined as the number of people one sick person infects over the course of their illness) is between 1.51-2.53, with a doubling time (defined as the time period required for the quantity of infected people to double in size) of 15.7 days (Althaus, 2015, Alexander et al, 2015). The incubation period is between 2-21 days; however, EBOV can persist in the semen of a male survivor for up to 18 months (WHO, 2016). Symptoms include fever, headache, abdominal pain, vomiting and diarrhea and myalgia, with 30-80% of patients experiencing hemorrhage, typically at the end of their illness. Fomite transmission is possible with exposure to contaminated surfaces and materials such as bedding, and clothing. EBOV persistence in the environment is still poorly understood. In simulated conditions to temperature and humidity, researchers found that EBOV can persist in hospital settings and in contaminated fluids for up to 14 days (Fisher, 2015).

Despite increases in health infrastructure in recent years, Senegal fails to meet the WHO recommendations for health coverage, lacks systematic disease surveillance programs and has been judged as poorly equipped to handle an EBOV epidemic, particularly in the southern regions (Diaw, 2014). The regional health center in Salemata, Kedougou, southeastern Senegal is the only one for 80km^2 with a population over 22,313 people within 1,970km.^{2} The Salemata health facility has 1 doctor, 2 pharmacists, 6 nurses, 3 midwives and a public hygiene specialist, servicing approximately 6,000 people in their catchment area (Camera, 2014). A deficit in trained staff and working equipment hinder prompt identification and containment of infectious diseases. Adherence to infectious disease protocols is particularly challenging due to erratic access to running water and unreliable electricity in the Salemata facility. None of the health facilities in the Salemata region are equipped to test EBOV lab samples via viral antigens through ELISA, identification of nucleic acid by PCR, antibody titers or virus isolation.

Despite these deficits, in comparison to neighboring infected countries Senegal has one of the strongest health care systems in West Africa. Their use of active contact tracing, utilization of short message service (SMS) messaging platform, enlistment of community health workers (CHWs) on educational campaigns and successful containment of one EBOV positive case supports Senegal’s ability to manage a small outbreak, particularly in the resource rich capital. In response to the EBOV epidemic in neighboring countries, Senegal’s MOH developed national training programs and worked closely with NGOs for a coordinated international response to fill gaps in coverage. NGOs and the MOH utilized trained CHWs, from previously established malaria campaigns, to disseminate information on a village level, ensuring culturally appropriate information sharing in local languages.

Beginning in April 2014, the NGOs Caritas, Croix de Rouge (through World Vision), Mundo de, USAID/Yaagende and Sadev began actively training villagers on EBOV prevention in a southeastern region of Senegal in the region of Kedougou called “Bassari Country”

(Appendix 7.5). Health campaigns included educational radio campaigns, posters, pamphlets and village level trainings promoting increased hygiene, vigilance and changes in bushmeat consumption. NGO and MOH workers and CHWs visited individual villages to educate villagers on human-to-human transmission risks by explaining the symptoms of EBOV, emphasizing the importance of avoiding bodily fluids of infected persons, engaging in safe burial practices, promoting increased hygiene and encouraging prompt care-seeking. CHWs and NGO workers also promoted preventive zoonotic disease transmission techniques by educating villagers about the risks of interacting with wildlife and consuming bushmeat (wild animals hunted for food). Senegal's MOH also reallocated an existing SMS-based diabetes national campaign and sent alerts in French concerning suspected EBOV cases in Senegal and educational prevention techniques; but due to poor cell phone service, low cell phone ownership and low literacy rates, Bassaris were excluded from benefiting from the EBOV SMS campaign. EBOV training programs in Sierra Leone were met with unwillingness to report EBOV and a preference for traditional medicine and burials (Jiang et al, 2016). Similarly, EBOV prevention campaigns in "Bassari Country" encountered resistance to western medicine, distrust of outsiders, conspiracy theories and misconceptions concerning transmission routes (Kroos, 2014, Boubane, 2014).

In November 2014 twelve informal interviews in "Bassari Country" and surrounding areas were conducted to evaluate public perceptions and willingness to adopt preventive behavioral changes (Kroos, 2014). Perceptions of risks were generally high and attitudes towards behavioral change were positive. A small proportion of people interviewed believed that they were immune to the virus because they kept themselves clean while others doubted its existence and labeled it western propaganda. Many were misinformed concerning its origins, claiming it was caused by "dirty water" or "brought on the wind." Many referred to Guineans' poor hygiene as the source of the epidemic (Kroos, 2014). Researchers in Sierra Leone in the summer of 2014 found more than 80% of people thought EBOV was caused by bushmeat, demonstrating a lack in understanding the role of human-to-human transmission and amplification (Richards et al, 2015). Information clustering, often the case with misconceptions, can affect successful interventions if communication pathways differ from disease dynamics (Funk et al, 2009). To combat misconceptions and promote preventive behavioral changes, NGOs and the MOH employed CHWs to visit villages and educate villagers in local languages on EBOV identification and prevention.

EBOV preventive health campaigns by NGOs and the MOH targeted "Bassari Country" because it serves as a potential location for a spillover and amplification event. Bassaris' spiritual beliefs in the power of nature, use of traditional medicine and cultural practices could delay care seeking and amplify an outbreak. In countries surrounding the epicenter of the outbreak, 70% practice traditional medicine (Alexander et al, 2015). Their ceremonies, habits and interpretation of illness are reflected in their beliefs in supernatural forces and the embodiment of their ancestors in nature (ICOMOS, 2012). Bassaris believe in a metaphysical world and uses masks and traditional medicine to ward off evil spirits. Masked villagers visit the sick and patrol their land while embodying protective spirits. Traditional medicines, provided by a medicine man, are often worn in leather pouches (*gris gris*) around one's neck (Boubane, 2014); these ethnomedicinal beliefs can impact care seeking, prognosis and transmission chains. Traditional burial practices take place over three days and involve washing the body and carrying the body into the forest for burial, potentially exposing people to highly infectious bodily fluids. Cultural practices such as concentrated living on family compounds (10-40 people) and home care for the sick could further influence pathogen transmission dynamics, particularly for human-to-human transmission.

Human travel poses a risk for a potential outbreak, specifically among Bassaris due to their proximity to EBOV infected zones. Despite officially closing Senegal's borders with Guinea from March 2014 through May 2014, it actually remained relatively porous, particularly on bush paths connecting Bassaris to Guinean villages. The lack of any clear demarcation of the border further exacerbated unregulated travel. Bassari schools also service Guinean communities across the border. Bassaris often traveled across the border to visit friends and family as well as for commerce. Despite the closure of the local weekly market in Salemata in "Bassari Country," the sole legitimate trading market for more than 80km, from April through August 2014, people still regularly moved across borders to attend informal markets. Bassari and Guinean congregate weekly at an illegal bushmeat market near the Guinean border to drink palm and sell bushmeat. According to my market study from May through July 2015, 40% of the bushmeat vendors/hunters originated from Guinea (Kroos, 2016). Due to a history of violent beatings and destruction of goods by authorities, attendees are distrusting of outsiders and conduct their trade on unmarked paths in the forest. Escalating artisanal gold mining in "Bassari Country" and along the Niokolo-Koba National Park's border also impact the convergence of different ethnic groups and nationalities on Bassari land. Contact with persons from infected regions prime "Bassari Country" for an outbreak.

Bassaris routine consumption of bushmeat poses a significant risk for pathogen transmission, particularly due to intensification of infectivity during the passage of EBOV between animals (Gale et al, 2015). Experimental passage of EBOV from a wild green monkey to a guinea pig amplified four to five times the order of magnitude (Gale et al, 2015). Limited data suggest non-human-primate- adapted EBOV, through bushmeat, may pose a larger risk than bat-adapted EBOV. Researchers speculate the number of intra- or interspecific passages affects infectivity to humans from bushmeat (Gale et al, 2015). Previous research in the surrounding area demonstrates the integral role of bushmeat economically and culturally despite its potential high infectivity (Ba et al., 2006). In an area with 26% chronic malnutrition, Bassaris rely on bushmeat as a reliable source of protein (FAO, 2006, Diaw, 2014). In a region with 71.3% poverty incidence, bushmeat is an affordable commodity with a weighted average estimated at 400-500CFA/kg (1USD/Kg) in comparison to 1200/CFA (3USD/kg) for beef (Ba et al. 2006, International Monetary Fund, 2013). In 2000, southern Senegalese rural households reported consuming bushmeat once to three times per month (Ba et al, 2006). EBOV is inactivated by cooking or boiling for five minutes at 60°C but the virus can persist in dried meat for over 50 days (Alexander et al, 2015). Zoonotic risk behavior through bushmeat hunting, storage and consumption is particularly concerning for Bassaris and has yet to be investigated in regions peripheral to EBOV infected zones.

Comprehensive knowledge is a key factor in adopting prevention strategies and promoting medical treatment/or attention seeking behavior. Previous studies have shown increased awareness of symptoms and transmission routes and community engagement can be attributed to intensive education and mobilization (Jiang et al, 2016). Measurable behavioral changes are associated with frequent, culturally specific, attractive attention-grabbing messages for extended time periods (Curtis et al, 2001). Previous research demonstrates easily identifiable symptoms paired with rapid information dissemination and protective behavior can significantly decrease infection rates. Senegal's MOH in collaboration with international NGOs sought to raise awareness and motivation about EBOV in hopes of facilitating preventive behavioral changes and averting future outbreaks. Simulations based on early epidemic data indicated observed fluctuations in the outbreak could not be explained by increased treatment capacity alone (Fast et al., 2015). Modeling the spread of awareness demonstrates lower disease incidence, regardless of broadcasting methodology. Simulated scenarios suggest social mobilization efforts increased awareness gradually. Simulations of the outbreak in Liberia, estimated behavioral change in EBOV infected zones, in response to social mobilization, began six weeks post outbreak (Fast et al, 2015). Models of social mobilization on education and awareness-induced behavioral change have been shown as pivotal drivers in curtailing EBOV.

Bassari people, an animist tribe of agro-pastoralists who were traditionally hunter-gatherers, are an at-risk demographic. Bassari people are spread across Gambia, Guinea, Guinea-Bissau and Senegal with populations between 10,000 and 30,000 with the majority residing in "Bassari Country" (ICOMOS, 2011). Bassari villagers are at risk for contracting EBOV due to their proximity to the Guinean border, routine bushmeat consumption, travel, interactions with Guineans at border bushmeat markets, ethnomedicinal traditions and inaccessibility to health care facilities. In response to the EBOV outbreak, NGO and MOH strategies focused on social mobilization by involving community leaders and CHWs to improve public awareness and practices towards EBOV prevention throughout Senegal with emphasis along the border and among at-risk demographics (Diallo, 2014, Boubane, 2014).

My quasi-experimental study was designed to identify strengths and weaknesses of targeted health campaigns' efforts to thwart human-to-human propagation and prevent future zoonotic outbreaks. In order to evaluate the success of these strategies in inducing behavioral shifts, I conducted 100 household structured surveys to investigate the hypothesis that the number of NGO/MOH visits in an area peripheral to a high EBOV infection zone affects the degree of behavioral change regarding EBOV risk. My work sought to determine the effectiveness of NGO/MOH visits in inducing preventive behavioral changes and identify demographic predictors that contribute to the likelihood of adopting preventive behavioral changes. I examined the influence of multiple NGO/MOH visits on specific behavioral changes that were related to human–to-human transmission prevention (changing travel patterns, hygiene and greeting practices) as well as preventing zoonotic risks (discontinuing consumption of bushmeat and avoiding wildlife contact) (Figure 1-1). Specifically, I hypothesized the following:

1. Individuals in villages that experienced multiple NGO/MOH visits will have an increased acquired knowledge of EBOV and increased behavioral changes.
2. Knowledge level, as measured by known causes of EBOV, will act as an intermediate outcome and function as a predictor for my primary outcome, behavioral change.
3. There will be no significant relationship between villagers' proximity to the bushmeat market and number of NGO/MOH visits on individual behavioral change.
4. Demographic variables, age, gender and religion, will have no effect on likelihood to adopt behavioral changes.
5. Participants with greater education will have an increased probability of behavioral change.
6. Individuals will have an increased likelihood of adopting preventive behavioral changes related to human-human transmission, such as hygiene and greeting, than zoonotic preventive behaviors, such as decreasing bushmeat consumption and avoiding interaction with wildlife.

I constructed my hypotheses based on existing research and knowledge of my study population. I hypothesized formal education would act as a predictor for increased likelihood of behavioral change based on the premise that education increases the acquisition of knowledge. I speculated that lower levels of education would be associated with poor knowledge of the known risks based on a study in Nigeria that found education level prior to EBOV preventive trainings significantly influenced knowledge of EBOV risks (Patel, 2016). Examining behavioral drivers, I hypothesized that increased knowledge would affect behaviors based on previous studies of perceived risk. In a risk perception study in Nigeria, 55% of participants were aware of risks associated with wildlife contact, of which almost half (26%) reported taking precautionary measures, indicating knowledge influences behavior (Friant et al., 2015). Increases in individual's perceptions of personal vulnerability and fear arousal can generate behavioral shifts (Becker and Janz, 1987). Studies demonstrating repetition and reinforcement impact behavioral change and knowledge supports my hypothesis that multiple NGO/MOH visits increase knowledge and behavioral change (Jiang et al, 2016, Curtis et al, 2001). I hypothesized minimal differences across locations (with no association between locations) and uniformity regarding health visits due to the villages' environmental, socioeconomic and demographic similarities and mass dissemination of health campaigns. I predicted demographic variables, such as age, gender and religion to have minimal effect on likelihood to adapt behavioral changes based on interviews with cultural experts (Boubane, 2015). To determine drivers of behavioral change and assess the impact of health campaigns I tested these hypotheses in a region peripheral to a high infection zone.

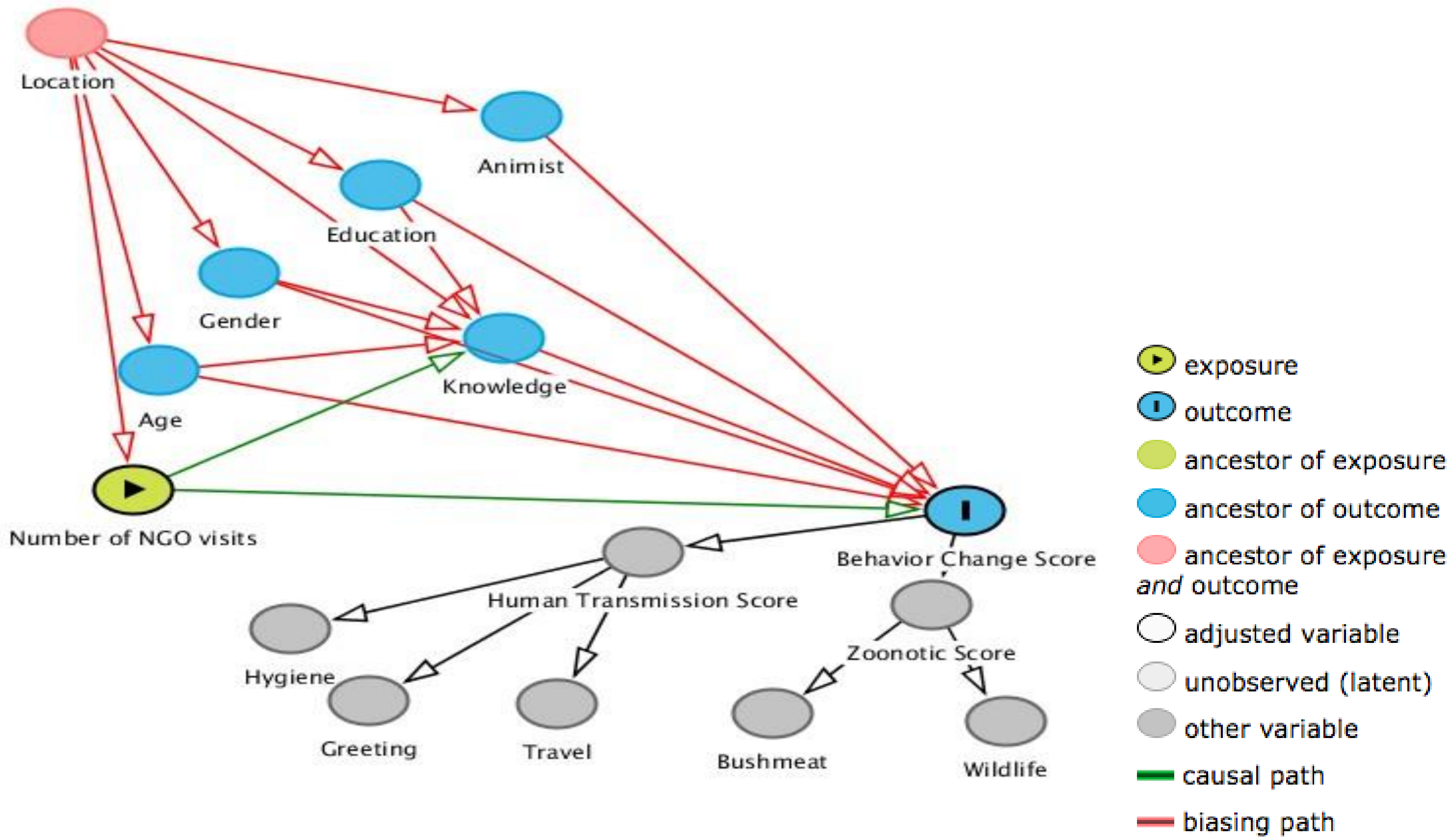

Figure 1-1: Diagram of Primary Hypotheses: Number of NGO/MOH Visits' Effect on Behavioral Change

Main Hypothesis: Multiple NGO/MOH visits is associated with increased behavioral change. Number of NGO/MOH visits is associated with an intermediate outcome on knowledge level, which affects behavioral change. I hypothesized villages location (proximity to the bushmeat markets) is unassociated with the number of NGO/MOH visits and demographic variables that impact behavioral change. To test these hypotheses, I examined the possibilities of biasing pathways (interaction) between number of NGO/MOH visits and location. I also examined the nesting effects between villagers from the same location on demographic variables and their impact on knowledge and behavioral change.

2 Methods

2.1 Study Setting

My study took place between May 20th and July 24th 2015 in seven villages in "Bassari Country," in the region of Kedougou located in the Salemata district of southeast Senegal. The study sites were located between 1 and 25 kilometers from the Niokolo-Koba National Park and the Guinean border in the northern foothills of the Fouta Djallon massif (Figure 2-1, Figure 2-2). In 2012, 8,856 people lived in the Bassari-Salemata area. The Bassari Salemata zone occupies 242 km^2 south of Salemata and is surrounded by a 1,634 km^2 wide buffer zone. These villages have no electricity, no sanitation facilities, no running water, poor cell phone coverage and seasonally impassable roads. Most Bassari people primarily speak a Tenda language, of the Oniyan minority languages, called Bassari. Only 30% of my study subjects, with a median age of 48 years old, reported some literacy. Typically, only health workers own cell phones, which are underused due to lack of electricity and cell phone reception (Boubane, 2015). Lack of sanitation, language and literacy barriers and inability to receive national SMS alerts are contributing risk factors for an EBOV outbreak among Bassaris.

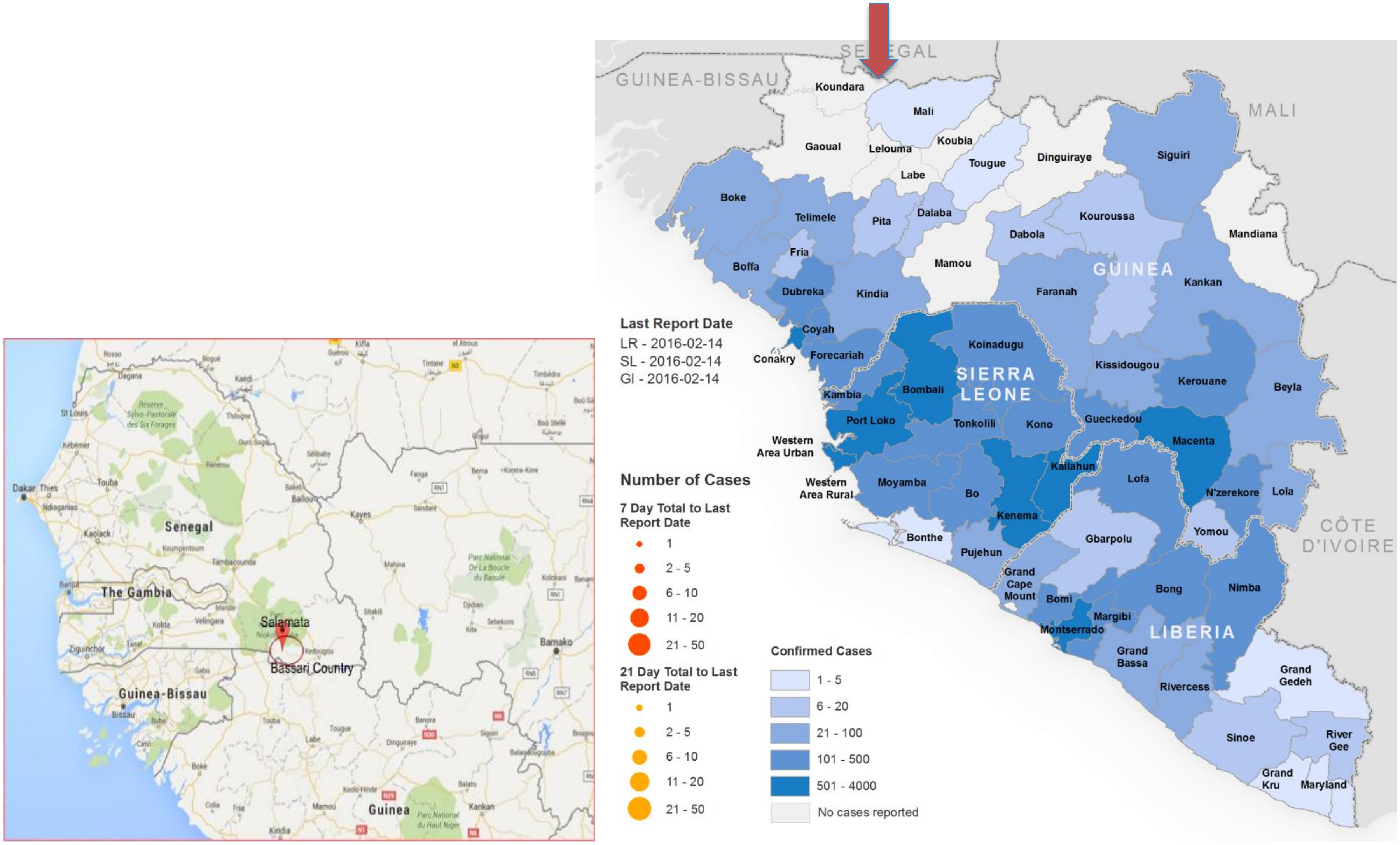

Figure 2-1 Map of Study Site in relation to High Ebola Infection Zones in Neighboring Countries

Reprinted from World Health Organization, In Emergencies, preparedness, response. Retrieved October 13, 2015, from http://www.who.int/csr/disease/ebola/maps/en/.

Figure 2-2: “Bassari Country” in relation to National Park and Guinean Border

Kedougou Map, Senegal. (n.d). Retrieved from Peace Corps Senegal

Southern Senegal is a potential location for an EBOV outbreak based on spatial distribution of environmental factors and wildlife. Senegal is located at the upper geographic limit for the distribution of suspected EBOV fruit bats reservoirs (*H. monstrosus, E. franqueti,* and *M. torquata*) as well as home to the *Mops condylurus* bat, a suspected source of the 2013 Guinean EBOV outbreak (Pourrut et al, 2007, Saéz, et al, 2015). Intermediate hosts of EBOV such as *Papio papio* (Guinea baboon), *Erythrocebus patas* (patas), *Cercopithecus aethiop* (grivet monkeys), *Pan troglodytes* (savannah chimpanzees) and *Sylvicapra grimmia* (common duikers) (Table 2-1) are also pervasive in “Bassari Country.” The shared ecological niche of reservoirs and intermediate hosts and seasonal long distance migration of suspected reservoirs (>2,500km) influence the distribution of epidemic clusters (Chippaux, 2014). Increased land conversion, (0.7% deforestation per year) and the close proximity of cultivated fields to primate habitat has resulted in human-wildlife conflict through high incidence of crop raiding (act of entering cultivated area and stripping plants for edible parts) by grivet monkeys, baboons, patas monkeys, and on occasion savannah chimpanzees (Dieng and Ndiaye, 2012). Interaction with EBOV hosts escalates Bassaris risk for a spillover event.

Table 2-1: Potential EBOV Reservoirs and Hosts in Senegal

Role	**Species**	**Common Name**	**Native to Senegal**
Suspected Ebola Reservoirs	*Hypsignathus monstrosus*	Hammer-head fruit bat	Upper Range
	Epomops franqueti	Franquet's epauleted fruit bat	Upper Range
	Myonycteris torquata	Little collared fruit bat	Upper Range
	Mops condylurus	Angolan free-tailed bat (insectivorous)	Yes
Ebola intermediate Hosts	*Pan troglodytes*	Savannah chimpanzee	Yes
	Cercopithecus aethiops	Grivet (Green monkey)	Yes
	Colobus badius	Western red colobus	Yes
	Papio papio	Guinea baboon	Yes
	Erythrocebus patas	Patas (Wadi monkey)	Yes
	Sylvicapra grimmia	Common duiker	Yes
	Cephlaopus rufilatus	Red-flanked duiker	Yes

2.2 Selection of Villages

Sites were selected based on their shared similarities in ethnic groups, proximity to wildlife habitat, distance from road, presence of agricultural farming and population size (100-350 people). All villagers were predominantly Christian animist, whom unlike Muslims, do not have a religious taboo on bushmeat consumption. Bassari was the dominant ethnic group at all sites who spoke primarily an Oniyan minority language also called Bassari. Due to language barriers, a local Bassari health worker worked as my translator and interviewed all of my subjects in Bassari. Villages were selected based on the number of NGO/MOH educational visits conducted in each site before May 2015. The villages were categorized by number of NGO/MOH visits based on interviews with NGO/MOH supervisors and review of CHW's and NGO/MOH supervisors' reports concerning names of villages visited, dates of visits and number of people trained. Due to discrepancies between NGO/MOH reports and village reports, number of visit were not scaled, rather they were categorized as either 'single NGO/MOH visit' (only one) or 'multiple NGO/MOH visits' (two or more).

All villages had a CHW assigned to its jurisdiction, who lived in or near his assigned village. CHWs were already well established in all of the study communities due to a previous regional malaria campaign. CHWs were specifically hired by NGOs to educate their fellow residents concerning EBOV preventions; these trainings were counted as NGO/MOH visits. CHWs did not visit residents regularly outside of weekly malaria sweeps. All villages had radio reception and picked up both Guinean and Salemata radio stations that typically broadcasted in Pulla Fuuta, the dominant language of Guinea and southeastern Senegal, with some French and Bassari targeted EBOV prevention messaging. Although not every household owned a working radio, villagers typically congregated around a neighbors' radio at night. Educational EBOV radio programs were therefore identified as a pre-existing intervention that equally exposed every participant to educational messages.

Data were collected between May 20th and July 24th 2015 in Bassari by a local translator and transcribed in English. I extrapolated number of adult males in each selected village using 2014 Ministry of Health census data (Camera, 2014). Based on these census data, I then estimated my minimal sample size per site to be 20% of the head of households, which would result in a sample size of 12-25 people per village. At least 20% of the head of households were surveyed in each of the seven villages. I continued sampling a village until I reached at least 20% of head of households to a total of 100 surveys in seven villages.

2.3 Sampling Method/Recruitment

Prior to surveying subjects, I met with the seven chiefs of each selected village to describe the goals of my research and the participants' rights to anonymity and confidentiality. After one week, I contacted the chief by cell phone or via bush mail. I was invited to conduct research at all seven of the villages I initially contacted. I approached each randomly selected home and asked to interview the head of household. Due to the high illiteracy rates, participants provided oral consent (Figure 2-3). I asked to survey participants in private to ensure confidentiality and encourage open discussion with the interviewer.

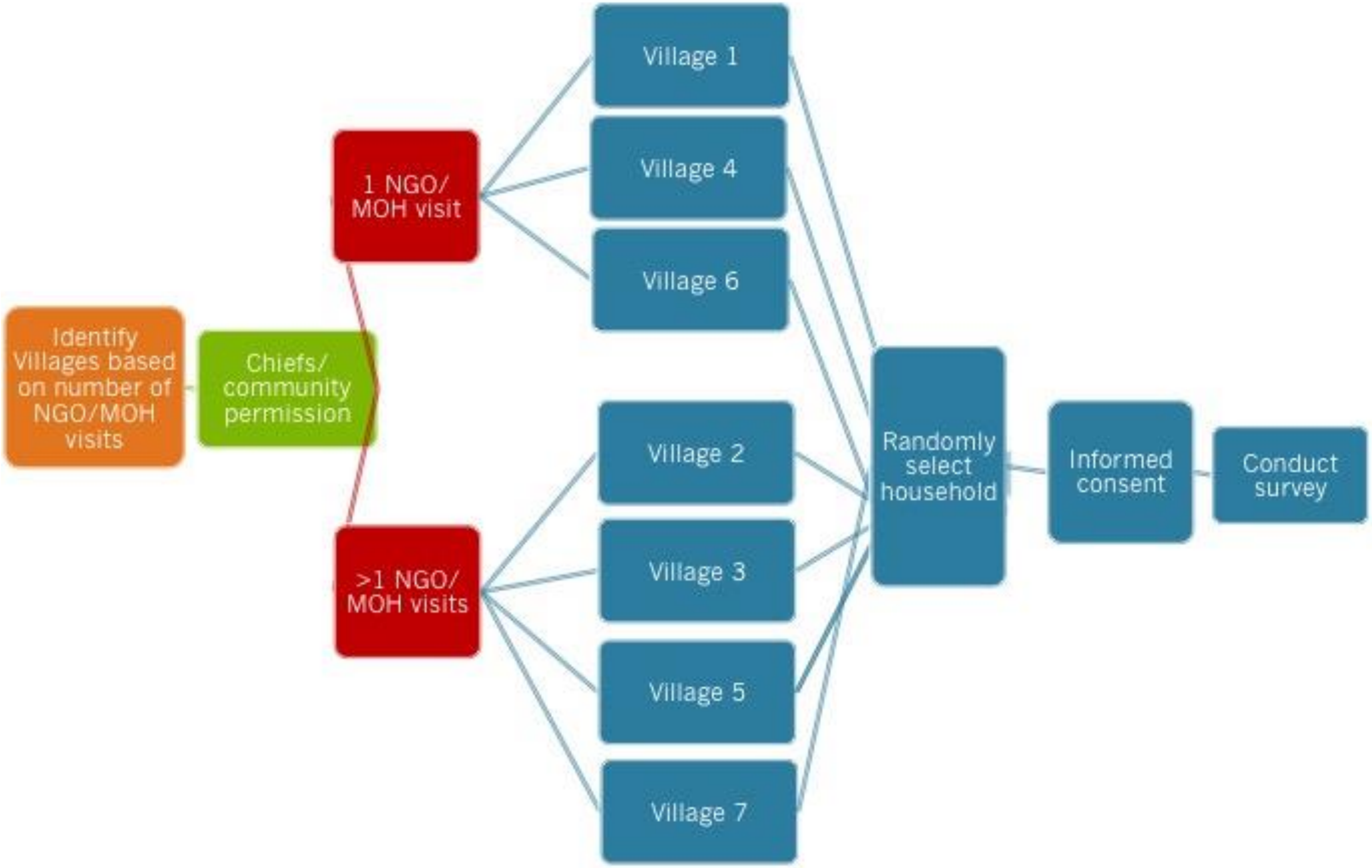

Figure 2-3: Study Design for Selecting Sites

2.4 Selection of Study Subjects

Structured questionnaires were administered to the head of household or head of household's spouse from seven villages in "Bassari Country" to investigate the impact of NGO/MOH visits on villagers' likelihood to adopt EBOV preventive behavioral changes between May and July 2015. I collected information regarding demographics, known causes of EBOV and responsive behavioral changes. I divided my study population of adult Bassaris into strata. I targeted male head of households because they were the main audience of NGO/MOH visits and because of their increased risk of EBOV transmission due to their traditional gender roles as hunters and butchers and head of household responsibilities to provide for their families. Households and individuals were selected using randomized stratified purposeful sampling. Approval to work with human subjects was granted on April 3, 2015 (HSD study #49407) from University of Washington Human Subjects Division. Participant's homes were randomly selected using the World Health Organization epidemiology survey coverage for rural single dwelling guidelines (WHO, 2008). A central location in the village was first selected based on proximity to the chief's house or central water pump. I then determined the first house by spinning blindly. I worked outwardly in a spiral formation to sample as many houses as possible. Households were randomly selected to be sampled based upon the outcome of a coin toss (Appendix 7.1).

2.5 Criteria for Eligibility/Exclusion of Cases

I surveyed the adult (over age 18 years) male head of household or, if unavailable, the spouse of the head of household, who had resided in the village for at least two years and identified as a non-Muslim Bassari. Adult males were the primary subjects; female participants, due to gender roles, often spoke less freely and had less knowledge of hunting patterns and were often excluded from attending educational NGO/MOH visits outside the home. Eligibility criteria regarding residence was set at two years to ensure participants were familiar with daily activities and cultural ceremonies that often only occur annually. Approximately 6 potential interviewees opted out of the survey, of which 5 were women. Approximately 10% of selected households were skipped due to the absences of adult head of households on the premises. Approximately 3% of households were excluded because the head of household was absent and his wife had not resided in the selected village for more than 2 years.

2.6 Description of Intervention

Based on interviews and review of NGO/MOH reported data, each site had exposure to at least one health visit that involved a trained CHWs disseminating EBOV prevention in Bassari. All village level EBOV prevention trainings focused on reducing human-to-human transmission and preventing future zoonotic outbreaks. Trainings covered topics relating to symptoms and causes of EBOV. Human-to-human transmission programs promoted regular hand washing, changing greeting practices to circumvent hand shaking, avoiding infected persons, recognizing signs, altering traditional burial practices and encouraging prompt medical attention. Zoonotic outbreak prevention education advised villagers to avoid contact with wildlife and cease bushmeat consumption. All of the health promotional material (posters and brochures) was printed in French, which was taught in public schools attended by Bassaris. The overall message was similar but the methods of disseminating information varied from impromptu campaigns in a central area to installation of hand washing stations and distribution of hand-washing kits to group demonstrations.

2.7 Data Collection

2.7.1 Survey Instrument:

The questionnaire was designed to provide information on behavioral change in response to NGO/MOH visits. The framework of my questionnaire was similar to questionnaires by Jiang et al. (2015), who assessed signs and symptoms, transmission routes and control measures of EBOV, and Holakouie-Naieni et al.'s survey (2015) that assessed knowledge, attitudes and practices regarding EBOV. Questions testing knowledge of EBOV symptoms, transmission routes and control measures were developed based on information disseminated in the Red Cross brochures and by CHWs. The questionnaire was pre-tested on two Bassari men who resided outside the study villages to ensure question comprehension, drop out points and survey length. To promote trust, I used a translator from the community who identified as Bassari and was fluent in Bassari and English. I was a resident and established community member in the region for 18 months before beginning the surveys and spoke the local language, Pula Fuuta.

Protective (positive) behavioral change was measured in terms of adopting any behavior that has preventive properties and was promoted by local health campaigns, which included improved hygiene, ceasing bushmeat consumption, avoiding wildlife, restricting travel or altering greeting practices. Behavioral change was considered a binary response variable (behavioral change, no behavioral change) based on self-reports of behavioral shifts within six months of the survey.

2.7.2 Data regarding interventions:

Prior to conducting surveys, I interviewed supervisors of each NGO and staff at the local health facility in French and Pular and collected data on which villages they visited, how often, date of visits, number of people trained, resources distributed and content of training. I reviewed, when available, each agencies' supervisors' monthly reports on the number of people trained, organized by gender and age, names of villages visited and dates visited. I crossed referenced these visit reports with the chief, chief advisor and village health worker at each village to ensure consistency. If inconsistencies arrived between NGO or MOH's reported trainings and villager's report I asked the NGO or MOH supervisor to interview the CHW who conducted the training to double check the report. To ensure consistency on a village level, I randomly selected an additional four villagers and asked about recent NGO/MOH visits. I used the variables 'single' and 'multiple visits' in order to adjust for inconsistencies between reported number of visits by villagers and the MOH and NGOs. I reviewed educational material (power points presentations, brochures, radio broadcasts and posters) that each organization used to train their staff and public. I determined main talking points for each organization and ensured consistency between organizations.

2.8 Statistical Analyses

R studio with Modern Applied Statistics with S package (MASS) and Linear Mixed-Effects Models using 'Eigen' and S4 package (lme4) was utilized to analyze my final model. I defined my response variable as having experienced a single NGO/MOH visit or multiple NGO/MOH visits within the last six months and my outcome variable as self-reported behavioral change or no behavioral change. Predictor variables were identified based on socioeconomic, geographic and cultural drivers of behavioral change among Bassaris: education, religion, knowledge, age, gender and proximity to the bushmeat market. Education, defined as having attended any formal schooling, was examined as a predictor of socioeconomic status and of knowledge of potential EBOV risk associated with bushmeat consumption; knowledge level was also examined separately. Knowledge was determined based on the participant correctly identifying causes of EBOV. Participant responses were then categorized as knowledgeable (able to correctly identify an EBOV host, reservoir or source of human- to human transmission) informed (identified general risks but unable to identify route or specific source) or poorly informed (identified incorrect mechanisms or unable to answer). Age was broken into three categories based on age groupings in the communities. Religious beliefs were classified as animist or non-animist due to the religion's strong involvement with nature and wildlife. Distance to bushmeat markets was considered a surrogate predictor variable for access to regular bushmeat. Villages were grouped based on distance to the bushmeat market; within ten kilometers of the bushmeat market (regular access) or more than ten kilometers (poor access) (Appendix 7.2, Table 7-1). The units of analysis were individual survey participants who are nested within two aggregated locations.

I tested my hypothesis that multiple NGO/MOH visits increased behavioral change with an exploratory likelihood ratio with all of my variables and examined the bivariate association with behavioral change (Table 2-2). I ran a binary logistic regression test to further test my hypothesis that multiple NGO/MOH visits increased behavioral change; assuming the relationship between the outcome and covariates within each exposure groups follows a binomial logistic function. These results were in agreement with the Pearson Chi Square test results. I ran a multi-variant ordinal logistic regression model to test my hypothesis that multiple NGO/MOH visits had a positive effect on acquired knowledge of EBOV and were significantly associated with behavioral changes. I tested my hypothesis that knowledge acquired affects behavioral change by setting knowledge as a covariant in a binomial logistic regression. To determine whether education was significantly associated with increased behavioral change I examined education as a covariant in the binomial logistic regression model. To test my hypotheses that demographic variables gender, age and religion had no effect on behavioral change I examined the likelihood ratio followed by a binomial logistic regression. I tested my hypothesis that preventive human transmission behavioral changes increased in response to multiple NGO/MOH visits regardless of location effects by examining specific behavioral types for villages near and far from the bushmeat market with multiple NGO/MOH visits.

To further examine potential simultaneous influence of two variables on my outcome, I tested my hypothesis that there was no relationship between site location and multiple NGO/MOH visits on behavioral change by examining a hierarchical nested effect with a Chi squared test (Table 7-5). My model assumed individuals were organized into two locations (less than 10 km from the bushmeat and more than 10 km from the bushmeat market) and were systematically different but not randomly assigned. I assumed the variance of the intercept of the hierarchical model was different between two locations (heteroskedastic), although the mean intercept was the same (2.92) at the two locations (Table 7-5). After which, I ran a binomial logistic regression with the interaction term "number of NGO/MOH visits" and "proximity to the bushmeat market" while excluding insignificant or highly correlated variables (age and gender).

I plotted the raw data distribution to visualize each village's degree of behavioral change in response to NGO/MOH visits while considering locational effects. After which, I ran probability estimates to determine drivers of behavioral change using an inverse logistic regression for categorical dependent variables (Appendix 7-4). I calculated an estimated probability for behavioral change for both locations for a single NGO/MOH visit and multiple NGO/MOH visits.

In order to apply a binomial logistic regression, I tested my data to ensure I met the assumption that the error terms were independent. To test my hypothesis that NGO/MOH visits were independent of villages' proximity to the bushmeat market, I ran a Spearman correlation test against each covariate using Statistical Package for Social Sciences (SPSS) v. 19 for analysis, which indicated that I could not reject the null hypothesis that number of NGO/MOH visits was independent of location (Table 7-3). The Pearson chi square test demonstrated a significant interaction between age and education ($p < 0.001$) with a 49% correlation (Table 7-4). Thus, subsequent tests omitted age to avoid multi-collinearity. There was a significant interaction between knowledge and proximity to market ($p=0.004$) and education and knowledge ($p=0.038$) but had correlations less than 30%. Correlations between variables that exceeded 40% were eliminated from the final model. A Pearson Chi squared test was also run to compare all covariates to ensure the proportional odds assumption was met and there was no significant multi-collinearity between covariates. The findings from these exploratory analyses varied some from my final model due to later adjustments for interaction effects and possible confounding.

Table 2-2: Exploratory Likelihood Ratio Test for Predicator Variables

	Proximity to Market (>10km)	**Multiple NGO/MOH visits (>1 visit)**	**Education (at least some elementary school)**	**Knowledge (informed)**	**Gender (Female)**	**Age (35-60)**	**Animist (practicing)**
Likelihood Ratio	3.49	6.78	0.35	5.85	1.36	1.68	0
P value	0.06	.009*	0.84	0.05	0.24	0.43	0.99

3 Results

3.1 Demographics

One hundred participants were interviewed in “Bassari Country” and of these surveys, 94 were complete. My data were fairly equally distributed across villages that had received a single NGO/MOH visits in comparison to villages that experienced multiple NGO/MOH visits (Mean 3; Range: 2-4) (Table 3-1). The survey targeted heads of household, resulting in under-representation of women and skewing gender results therefore gender was excluded in the final model. Age groups were not equally distributed with 65% falling in the 36-60 years old age group. The median age of respondent was 48 with 70% of the population having never attended school. Younger respondents were more likely to have attended school than older generations; 69.6% of younger respondents (age 18-35 years old) attended school while only 14.9% of older respondents (age > 36 years old) attended school (Table 7-2). Practicing animism was present in a little less than half of the respondents. Socioeconomic status, measured by domestic meat consumption, was fairly uniform between the two groups.

Table 3-1: Distribution of participants by proximity to market, socioeconomic status, age, gender, education and religion

Independent Variables		**1 NGO visit (n=40)**	**>1NGO visit (n=60)**	**Total (n=100)**
Location: Proximity to Market	<10km	26 (65%)	36 (60%)	62
Socio-economic status	Frequent domestic meat consumption (>1x/month)	22	17	39
Gender	Male	35(87.5%)	46 (76.7%)	81
Age (years)	18-35 (median=27)	10 (25%)	13 (21.7%)	23
	36-60 (median=48)	25 (62.5%)	40 (66.7%)	65
	>60	5 (12.5%)	7 (11.7%)	12
Education	None	26 (65.0%)	44 (73.3%)	70
	At least elementary school	14 (35%)	16 (27%)	30
Animist	Yes	21(22.3%)	30 (31.3%)	51
(n=94)	No	19 (20.2%)	24 (25%)	43
	N/A	6		

3.2 Number of NGO/MOH Visits

Experiencing multiple NGO/MOH visits were significantly associated with the likelihood of behavioral change ($p=< 0.001$). An individual was 0.02 times less likely to change their behavior with multiple NGO/MOH visits (Table 3-2).

3.3 Location

Villagers' proximity to the bushmeat market was significantly associated with behavioral change ($p=.03$). Individuals who lived farther from the bushmeat market (>10km) were 0.06 times less likely to report behavioral changes (Table 3-2).

3.4 Knowledge

The number of NGO/MOH visits impact on increased knowledge acquired revealed no significant association between knowledge and increased behavioral change. Knowledge level when set as a covariate did not moderate the effect of number of NGO/MOH visits on behavioral change ($p=0.11$) (Table 3-3). There was no evidence that either location close to bushmeat market (<10km) ($p=0.603$) and far from bushmeat market (>10km) ($p= 0.954$) impacted number of NGO/MOH visits' effect on knowledge. Change in knowledge level was not associated with behavioral change in response to multiple NGO/MOH visits.

3.5 Education

Education was not significantly associated with behavioral change. Education was significantly correlated with knowledge (p=0.04) (Table 7-3).

3.6 Animism

Animism did not have a significant impact on overall behavioral change (p=0.40).

3.7 Interaction Effect Between Location and Multiple of NGO/MOH Visits

To report significance of the main and interaction effects under the null hypothesis that multiple NGO/MOH visits' effect was not a significant predictor of the behavioral change, I examined predictor variables one by one in an exploratory analysis using the likelihood ratios Chi squared. I found number of NGO/MOH visits (tested as a single predictor variable) was a significant predictor for behavioral change (p=0.009). Using a multiple regression test, I found there was a strong interaction effect between locational differences and NGO/MOH visits (single vs. multiple) (p<0.001) with all other covariant held constant (Table 3-2). A graphical depiction of the data revealed villagers residing closest to the bushmeat market were associated with a decreased likelihood of adopting preventative behavioral changes (Figure 3-1). I found the strong interaction between location and number of NGO/MOH visits on behavioral change varied based on location (p<0.001). Villages were trained equally across locations (Chi=.614) however NGO/MOH visits did not result in equal behavioral change outcomes across locations. Interpreting on the odds scale, with all other variables held constant, I found no significant effect on behavioral change in villages more than ten kilometers from the bushmeat market with multiple NGO/MOH visits. Individuals who experienced multiple NGO/MOH visits in locations within ten kilometers to the bushmeat market were 0.02 times less likely to change their behavior ($p<0.001$) (Table 3-4).

3.8 Behavioral Change Type

I found no clear behavioral type driving behavioral change. The direction of the effect between locations within behavioral types for multiple NGO/MOH visits was the same as the overall trends for each location. Neither NGO/MOH visits, location, knowledge nor demographic variables significantly affected behavioral changes related to wildlife interaction, greetings or travel (Table 7-7, Table 7-8, Table 7-14). Investigating impacts on specific behavioral types, I found that human score was significantly affected by knowledge acquired ($p=.001$) but was unaffected by any other variable (Table 7-6). The human score followed the overall negative trend with hygiene appearing most responsive (Table 7-9). Further breakdown demonstrated multiple NGO/MOH visits in locations near the bushmeat market ($p=0.002$) were less likely to change hygiene behavior (Table 7-10). Zoonotic behavioral changes were significantly affected by location, number of NGO/MOH visits, animism, and knowledge, which were primarily driven by bushmeat behavior (Table 7-11). Multiple NGO/MOH visits, location ($p<0.001$) and practicing animism ($p=0.01$) significantly affected bushmeat behavior (Table 7-12). Multiple NGO/MOH visits and proximity to the bushmeat market were significantly less likely to affect bushmeat and hygiene behavior.

Overall, multiple NGO/MOH visits in villages near the bushmeat market were associated with smaller odds of change in the behavioral types hygiene and bushmeat practices. Villagers within ten kilometers to the bushmeat market were less likely to change their bushmeat practices than villagers more than ten kilometers from the bushmeat market (Table 7-13). In the villages within ten kilometers to the market there was only a 48% reported behavioral change among villagers. Overall, multiple NGO/MOH visits more than 10km from the bushmeat market were not significantly associated with increased odds of behavioral change, regardless of behavioral type.

Table 3-2: Interaction Effect of Number of NGO/MOH visits and Location effect on Behavioral Change using a Binomial Logistic Regression

Coefficients	**Estimate (β)**	**P value**	**Odds Ratio**	**95% Confidence Interval**	
(Intercept)	2.42	0.02*	11.27	1.39	91.48
Location (>10km from bushmeat market)	-2.74	0.03*	0.06	0.01	0.73
Number of NGO/MOH visits (>1NGO/MOH visit)	-3.78	<.001**	0.02	0.00	0.21
Animist (practicing)	0.50	0.40	1.65	0.51	5.30
Education (at least some elementary school)	0.26	0.54	1.30	0.56	2.99
Knowledge: informed	1.30	0.11	3.68	0.76	17.92
Knowledge: knowledgeable	1.09	0.11	2.96	0.77	11.34
Difference of locations* > 1 NGO/MOH visit	5.26	<.001*	191.61	9.79	3749.89

Table 3-3: Interaction of Multiple NGO/MOH Effect and location on Knowledge Score using a Multi-Variant Ordinal Logistic Regression

Coefficients:	**Estimate (β)**	**P value**	**Odds Ratio**	**95% Confidence Interval**	
Location (far from bushmeat)	0.98	0.15	2.66	0.74	10.60
> 1NGO/MOH visit*<10km to bushmeat	-0.27	0.60	0.77	0.28	2.10
> 1NGO/MOH visit*>10km from bushmeat	0.04	0.95	1.04	0.26	3.92
Animist (practicing)	0.16	0.69	1.18	0.53	2.63
Education (at least some elementary school)	0.58	0.04	1.79	1.03	3.23

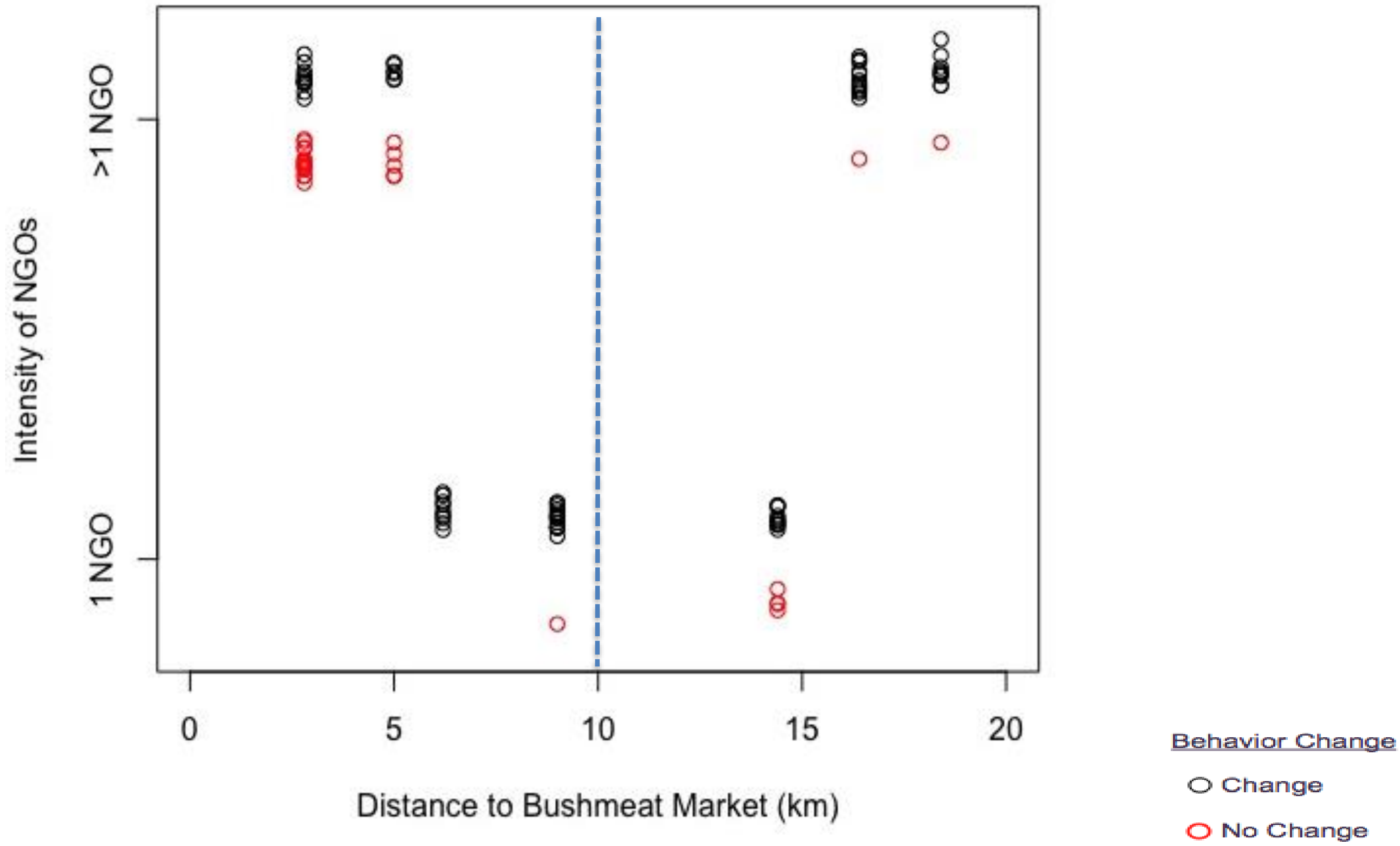

Figure 3-1: Proximity to Bushmeat Market Affects Health Campaigns' Impact on Behavioral Change

Note: There are only two responses on behavioral change, change or no change. In order to visually understand, plots are vertically jittered in order to emphasize the number of respondents.

Table 3-4: Location and Multiple NGO/MOH visits impact on Behavioral Change using a Binomial Logistic Regression

Coefficients:	**Estimate (β)**	**P value**	**Odds Ratio**	**95% Confidence Interval**	
(Intercept)	2.42	0.02*	11.27	1.39	91.48
Location (>10km from bushmeat market)	-2.74	0.03*	0.06	0.01	0.73
> 1NGO/MOH visit* <10km to bushmeat market)	-3.78	<.001**	0.02	0.00	0.21
> 1NGO/MOH visits * >10km from bushmeat market)	1.48	0.14	4.38	0.63	30.39
Animist (practicing)	0.50	0.40	1.65	0.51	5.30
Education (at least some elementary school)	0.26	0.54	1.30	0.56	2.99
Knowledge: informed	1.30	0.11	3.68	0.76	17.92
Knowledge: knowledgeable	1.09	0.11	2.96	0.77	11.34

3.9 Probability Estimates for Drivers of Behavioral Change

According to my inverse logistic regression probability estimates, individuals who experienced multiple NGO/MOH visits in villages less than ten kilometers to the bushmeat market were 41% less likely to change their behavior in comparison to villages that experienced only one visit (Table 3-5, Figure 3-2). For individuals who lived more than ten kilometers from the bushmeat market there was no significant association with multiple NGO/MOH visits and behavioral changes although my model predicted that people who lived farther from the bushmeat market were 16% more likely to change their behavior.

Table 3-5 : Estimating Probability of Multiple NGO/MOH visits and Location using an Inverse Logistic Regression

Number of NGO/MOH visits	**<10km to bushmeat market**	**>10km to bushmeat market**
1 NGO/MOH visit	98.10%	78.60%
>1 NGO/MOH visit	57.20%	94.90%
Difference in behavioral change	-41%	16.30%

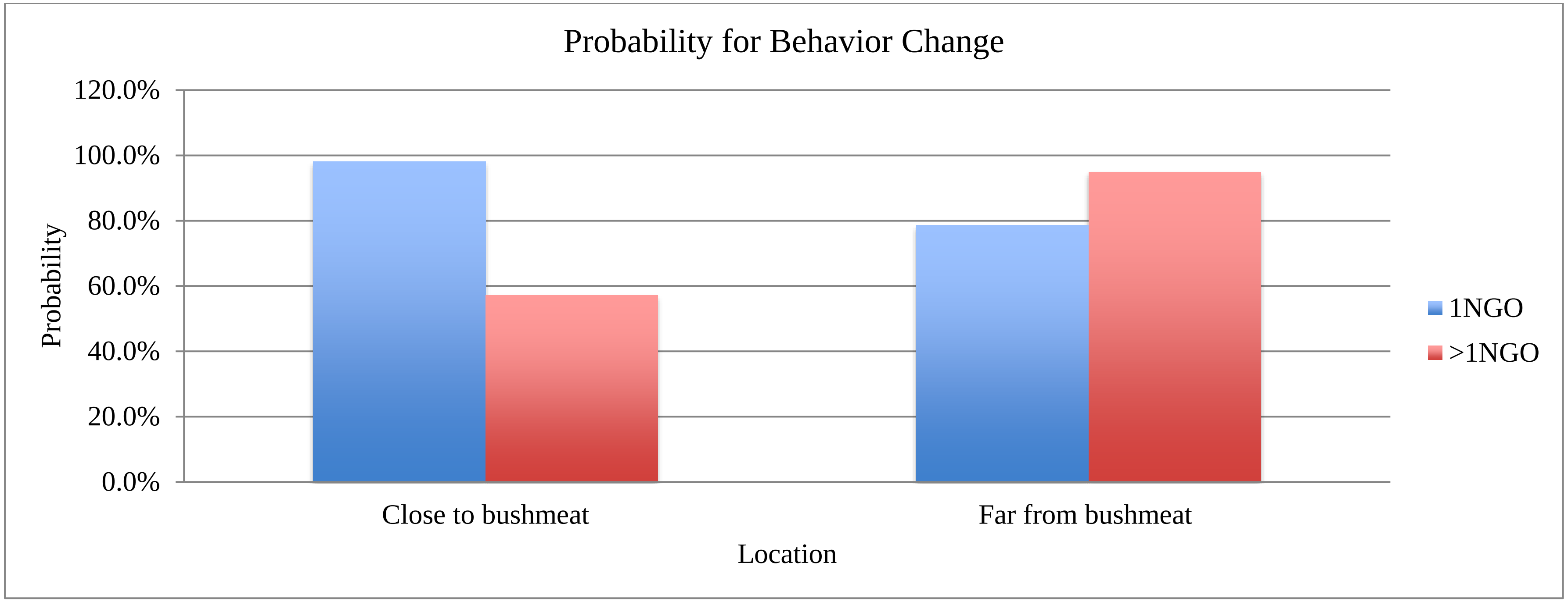

Figure 3-2: Probability Estimates for Behavior Change in response to Location and Number of NGO/MOH visit using an Inverse Logistic Regression

4 Discussion

My findings conflict with the general belief that more in-person education promotes adoption of behavioral changes; instead my research suggest multiple NGO/MOH visits were not more influential than a single NGO/MOH visit in inducing preventive behavioral change and were significantly affected by geographic differences. Despite distributing hand washing kits and demonstrating hand-washing techniques there was no difference in hygiene practices in villages with multiple NGO/MOH visits. Multiple NGO/MOH visits were unsuccessful in decreasing zoonotic high-risk behaviors, particularly in villages with regular access to bushmeat. My work disputes perceptions that literacy or education affects the likelihood of an individual experiencing behavioral changes. I found that knowledge scores were a poor predicator for the probability of reporting behavioral changes and NGO/MOH visits had no significant impact on knowledge acquired.

4.1 Number of NGO/MOH Visits Effects

My results showed no significant behavioral change relating to preventing human-to-human transmission, particularly increased hygiene, with multiple NGO/MOH visits and distribution of hand washing stations or kits. These findings contradict researchers' estimation that protection kits in conjunction with increased awareness could decrease household transmission by 90% (Merler et al, 2015). Despite, recent modeling of spatiotemporal spread in Liberia supporting providing hygiene kits during trainings, my work demonstrates hygiene kits and trainings were unsuccessful in promoting increased hygiene in regions peripheral to high infection zones. Hygiene kits, included soap and bleach, were quickly depleted and hand-washing buckets were often reallocated for alternative functions. Campaigns failed to provide sustainable access to cleaning materials and shift perspectives concerning the value of improved hygiene. Similarly, NGO/MOH visits promoted cessation of bushmeat consumption but did not offer alternative sources of protein or promote improved husbandry or sustainable agriculture. The significant negative relationships between number of NGO/MOH visits, hygiene and bushmeat behavioral changes could be due to the impracticality required to successful adopt these behaviors. Water scarcity, distance to wells or water pumps, socioeconomic status, and family size may affect likelihood of adopting improved hygiene behaviors. In fact, educated individuals were significantly more likely to consume bushmeat than individuals who had never attended school. Individuals who actively practice the religion animism had a decreased likelihood of bushmeat consumption and potential exposure to EBOV (Kroos, 2016). The availability of domestic meat sources (socioeconomic status), access to bushmeat and cultural and religious practices most likely affect individuals' feasibility of ceasing bushmeat consumption.

In my study, 63% respondents identified health workers as the most effective in inducing behavior change yet still showed no significant adaptions (Figure 7-1). Nigerian studies on different modes of delivery for health messaging found high rates of behavioral change from health messages heard from peers or family members (Ilesanmi and Alele, 2015). Adoptions of preventive behavior may have been augmented if key members of the community were involved and led by example. Inconsistent coverage due to convenience trainings may have also contributed to poor adoption rates. Targeted campaigns often lack adequate coverage, reaching on average 40% of intended audiences (Synder and Hamiton, 2002). In some sites, NGO/MOH visits had merely begun three months prior to the survey assessment and were disproportionately staggered. Utilizing locally appropriate channels in promoting behavioral change and repeating trainings for extended time frames have been shown to boost hand-washing behavior (Curtis et al, 2001). Increased intensity and consistently staggered visits may be needed to encourage behavioral changes.

4.2 Location Effects

Multiple NGO/MOH visits in locations within ten kilometers to the bushmeat market were significantly less likely to induce behavioral changes for unclear reasons. A Nigerian study examining the effects of different modes of EBOV education on improved hand washing behavior found respondents who had heard campaigns in church were 2.2 times more likely to improve hand washing (Ilesanmi and Alele, 2015). This suggests a group effect among people from the same community. This reasoning supports the possibility of a location interaction effect with the number of NGO/MOH visits on behavioral changes, as seen in villages clustered near the bushmeat market. Bushmeat consumption was associated with locations close to the bushmeat market with multiple NGO/MOH visits signifying access may have an influential impact. Practicing animism was significantly associated with less bushmeat behavioral changes in villages close to the bushmeat market, indicating cultural differences in locations may play a pivotal role (Kroos, 2016). The difference between locations may also be attributed to the availability of bushmeat and wildlife density or hunting enforcement rates among peripheral villages to the bushmeat market. Frequency of bushmeat consumption has been shown to decreases as distance to protected areas decreases, indicating hunting is lower in areas adjacent to national park that have high enforcement activity (Geppl, Nlelsen, 2014). The villages clustered near the bushmeat market were farthest from the national park (>10 kilometers), which potentially contributed to bushmeat availability. Among Ghanaians, 49% of bushmeat consumers were aware of the risks associated with bushmeat consumption but were not dissuaded from continued consumption (Kuukyi, Amfo-Otu, & Wiafe, 2014). Researchers on bushmeat drivers speculates public health campaigns could be effective at increasing disease transmission risk strategies but will be ineffective in reducing bushmeat harvest rates (LeBreton et al., 2006).

Distrust of outsiders may have also furthered the association with multiple NGO/MOH visits in villages close to the bushmeat market and being unwilling to embrace preventive behaviors. Anecdotal evidence reported by health workers and villagers testified to recent violent interactions between authorities and villagers concerning the illegal nature of the bushmeat market. Numerous villagers reported being beaten, imprisoned or having their belongings confiscated or camp burned when they were caught inside the park, hunting or attending the bushmeat market. This anecdotal evidence supports the hypothesis that locations closest to the bushmeat market could be more resistant to adopting behaviors promoted by outsiders. Emphasizing health campaigns that include messages about enforcement in comparison to persuasive campaigns have been shown to largely increase behavioral change; however, in locations with negative associations with enforcement agencies the effect is unknown (Synder and Hamiton, 2002). In fact, in July 2015, Bassari villagers near the park's border were involved in a violent riot protesting park guards' mistreatment and violent persecution of Bassaris regarding illegal hunting and palm wine harvesting (Foufana, 2015). Volatile interactions with authorities may have contributed to villagers' resistance to outsiders and affected their response to EBOV health visits.

4.3 Education and Knowledge Effects

EBOV risk is affected by socioeconomic heterogeneities among regions and ethnic groups. Transmission models found 3.5 times more EBOV transmission in improvised settings with wider disease propagation between communities. People of lower socioeconomic status were associated with more contacts during their symptomatic infectious phase. Lack of education has been postulated as a contributing factor towards the observed difference in number of secondary cases in different socioeconomic levels (Fallah et al, 2015). Kedougou households have high rates of illiteracy, with 32.3% of males and 54.6% of females reporting never receiving any formal education (World Data Atlas, 2011). Among Bassaris surveyed, I found 70% of respondents lacked any formal education. EBOV training in Nigeria found pre-trainings education level significantly influenced knowledge. Post-training differences were negligible (Patel, 2016). These results support my findings that education was not significantly associated with an increase in knowledge level or behavioral change post intervention. In fact, 31% of respondents were unable to correctly identify any cause of EBOV, including reservoirs, hosts, or high-risk behaviors. Knowledge level was not significantly associated with preventive behavioral shifts, indicating knowledge level, without a baseline prior to interventions, is not a valid predicator for behavioral change.

4.4 Limitations:

Many NGO's did not record demographic or quantitative data after completing trainings. Often health workers conducted convenience trainings with groups of people at a central point. Due to these impromptu gatherings women and teens were often excluded from these trainings and male partners did not disseminate the information equally (Diallo, 2014). Follow-ups by some NGO supervisors found false reporting by CHWs, which inflated the number of visits or villages visited (Boubane, 2014). Missing data (villages visited, quality of people trained, resources allocated, timelines, follow up) was a common hindrance. During each survey, at least 3 members of the community, typically the chief, second in command and a health worker, were interviewed concerning quantity of NGO/MOH visits. The number of visits and dates of visits reported by villagers conflicted with reports from NGOs and MOH. Since false reporting was confirmed in some of the NGO reports, I did not scale the number of visits (once vs. twice vs. three visits); instead I used single versus multiple visits as my predictor variable. Some visits may not have occurred or may have had a lower profile in comparison to other visits in other villages. Differences in the quality of visits could not be controlled for. Informal CHWs educational contact was minimal and was typically limited to passing conversations. CHWs informational interactions with residents could not be controlled and could have diluted the effect of the NGO/MOH visit.

Radio coverage began at least four months prior to any NGO/MOH campaign in the area. Since no site lacked radio coverage and radio EBOV messaging began before any NGO/MOH visits I could not deduce that NGO/MOH visits were the sole contributor to reported behavioral changes. In my study, only 21.7% of respondents identified radio as the most influential mode of health message delivery in inducing behavioral change, which may be affected by low radio ownership (47% of respondents owned a working radio). Low radio ownership and low self-reported impact on behavioral change indicates a potential small inflation effect on NGO/MOH visits impact on behavioral change. Hand-washing studies in Ghana support pairing community trainings with mass media to yield greatest effect; listening to radio promotions yielded an increase of 2-16% (based on number of channels) while paired events resulted in a 30% increase in reported hand washing with soap (Scott et al.2007). The lack of any significant benefit by duel exposures in my study, radio and community trainings, could indicate that villages were already saturated with information by the time health visits began. Without control villages with no previous EBOV health training exposures, I cannot rule out the possibility that NGO/MOH visits may have had a diluted effect due to previous widespread radio coverage in the area.

Road accessibility and distance to healthcare facilities may impact how many

NGO/MOH visits each site received causing a disproportionate allocation of trainings (villages varied between 1-4 visits) and as a result varied response rates. Since NGO/MOH visits were not randomly assigned they may have targeted higher risk groups disproportionately. The lower response rate may not be indicative of behavioral changes if they had a different baseline. Data collection was based on self-reporting concerning behaviors discouraged by health campaigns. Exaggerations of self-reported behavioral change could not be discounted, particularly for bushmeat consumption, since it is associated with an illegal activity. This may have inflated my results indicating the actual effect on behavioral change may have been even less.

My regression models are limited by endogeneity, which assumes behavioral change (dependent variable) is influenced by the independent variables in a causal manner and does not control for simultaneous effects on the dependent variables by independent variables. Some variables were excluded or may have been skewed due to multi-collinearity. Uncontrolled confounding factors may have existed and affected my results. My study assumed all important variables were investigated and omitted variables could not affect the estimation of the coefficients. My study investigated available factors and identified potential genuine factors that impacted behavioral change for future studies. My study lacked a comparison to a baseline survey on behaviors prior to EBOV. Small sample size may limit the generalizability to other EBOV infected peripheral zones. Sustained behavioral change patterns are unknown. Despite these limitations, my sample size per village covered more than 20% of subjects, confounding was minimized with randomization and exclusion of variables, questionnaires were cultural appropriate and trust was well established.

5 Conclusions

Rural communities with poor health facilities, like Bassaris villages, have been identified by the World Health Organization as key populations to be reached in efforts to prevent emerging infectious diseases. The results of this study indicate that multiple NGO/MOH visits are ineffective in inducing behavioral changes in areas peripheral to infection zones during a disease outbreak. Locational differences (such as how far a village is from the area of active outbreak or distance to bushmeat sources) plays a crucial role in behavioral adoption rates, which vary based on behavior type. Interventions should begin with targeting those living closest to bushmeat markets and with capital to purchase bushmeat. Since religious beliefs strongly influence bushmeat consumption, religious leaders must be encouraged to engage in participatory teaching and be involved in disseminating information in their communities (Kroos, 2016). Educational campaigns need to emphasize which bushmeat species to avoid, instead of advising to cease all bushmeat consumption. Legal hunting of non-EBOV hosts should be encouraged to preserve cultural practices. Since cost and access are the main drivers of bushmeat consumption, donating livestock, improving husbandry techniques or providing improved varieties of goats and fowl for larger returns can help boost yields and drive down costs of domestic meat alternatives (Kroos, 2016). The lack of improved hygiene with the distribution of hygiene kits and installation of hand washing stations suggests assess to hand washing equipment was not a significant obstacle. Campaigns should focus on promoting the protective qualities of improved hygiene rather than distributing unsustainable products. Since education level had no impact on the likelihood of adopting preventive behavioral changes, all villagers, including women and adolescents, should be targeted during health visits. Specializing health campaigns to address factors that influence willingness to adapt preventive behavioral changes is necessary to mitigate and manage emerging pathogens.

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7 Appendixes

7.1 Methods for Randomized Household Selection

Adapted WHO Epidemiological Survey Methods: Method 1: Randomly select households to be visited when household lists are unavailable (WHO, 2008)

1. Select a central location in the village or town, such as a large ceremonial tree with sacrificing stone or chief's house. The location should be near the approximate geographical center of the village or area.
2. Randomly select the direction from the center. This was done by spin in a circle with eyes closed.
3. Walk in the selected direction until you reach the first house.
4. Flip a coin to determine if you will conduct a survey at this household.
5. The second household you should visit will be the one which is nearest to the first. The next nearest household is the one whose front door is closest to the front door of the household you have just visited. Work outwardly in a spiral formation.

7.2 Definition of Outcome Variable

The behavior change score was run as a binary variable (none, behavior change). An individual, non-weighted behavior change score was assigned to each participant where a number represents positive behavior change in response to EBOV health campaigns. Equal weight was assigned to each behavior change category that evoked a self-reported change. Increased changes were identified as adopting behaviors that were promoted by all health campaigns by NGO's or the MOH to decrease risks of contracting EBOV from wildlife or human hosts. No behavior change, unrelated changes or uncontrolled outcomes were assigned a score of zero. Behavior changes were divided into subcategories related to prevention of human-to-human transmission and preventive measures from contracting EBOV from a zoonotic source and run as an ordinal variable (none, low, high behavior change) and as a binary variable (none, behavior change). Each behavior change was run individually as a binary logistic regression or ordinal logistic regression to determine if multiple NGO/MOH visits disproportionately affected a particular behavior change more than others.

Table 7-1: Determinants of Behavioral Change Outcome Variable

Category	**Behavioral Change Reported**	**Score**
Positive Change	Stop consuming bushmeat	1
	Not feeding wildlife	1
	Improve hygiene	1
	Change greeting practices	1
	Change in travel	1
Unrelated changes (misinterpretation)	Vaccinate cows	0
	Other (clean home, clean water)	0
Uncontrollable outcomes	Decrease tourism	0

7.3 Analysis: Supporting Material

Table 7-2: Person Chi Squared test: Difference in Age Groups and Education

Independent Variable	**Chi Squared**	**P value**
Age (18-35years)	22.92	<.001

Table 7-3: Spearman Correlation Table: Examining Covariates for Multi-collinearity

	Proximity to market		**Age**		**Animist**		**Knowledge**		**>1 NGO/MOH visit**		**Education**	
	rs	**p**	**rs**	**p**	**rs**	**p**	**rs**	**p**	**rs**	**p**	**rs**	**p**
Proximity from bushmeat market (>10km)	-	-	-	-	-	-	-	-	-	-	-	-
Age 35-60 years	0.14	0.17	-	-	-	-	-	-	-	-	-	-
Animist (practicing)	-0.6	0.57	0.03	0.79	-	-	-	-	-	-	-	-
Knowledge: informed	0.29	.004*	-0.03	0.79	-0.01	0.94	-	-	-	-	-	-
>1 NGO/MOH visit	0.05	0.62	0.002	0.82	-0.03	0.77	-0.03	0.77	-	-	-	
Education (at least some elementary school)	0.01	0.9	-0.49	<.001*	-0.11	0.3	0.21	.04*	-0.05	0.63	-	-
Gender (Female)	0.015	0.15	-0.12	0.23	0.07	0.52	-0.1	0.3	0.14	0.18	-0.14	0.17

Table 7-4: Pearson Chi Squared Test Statistic to Determine Significant Variable that Affect Behavioral Change

Coefficients	Chi squared	P value
>1 NGO/MOH visit	6.32	0.012*
Proximity to Bushmeat Market (>10km)	3.32	.068*
Animist (practicing)	0	0.992
Education (at least some elementary school)	0.332	0.847
Gender (Female)	1.43	0.231
Knowledge: informed	6.08	0.048*
Age (35-60 years)	1.82	0.403

Table 7-5: Hierarchical Model testing for Nested Effect between locations

Coefficients	**Estimate (β)**	**P value**
Intercept	2.92	0.01
Proximity to bushmeat market (>10km)	-2.4	.04*
>1NGO/MOH visit	-3.6	.001*
Animist (practicing)	0.48	0.4
Education (at least some elementary school)	0.32	0.42
Proximity to bushmeat market (>10km) * >1NGO/MOH visit	5.2	<.001*

1.7.1 Human-Transmission Sub Score Analysis

Table 7-6: Human Transmission Score as Outcome

Coefficients	Estimate (β)	P value	Odds Ratio	95% Confidence Interval	
Location (>10km from bushmeat market)	0.81	0.08	2.24	0.92	5.52
NGO/MOH visits (>1 NGO/MOH visit)	-0.62	0.18	0.54	0.22	1.31
Animist (practicing)	0.10	0.82	1.11	0.45	2.71
Education (at least some elementary school)	-0.06	0.82	0.94	0.52	1.65
Knowledge: informed	2.83	<.001*	17.00	4.32	88.66
Knowledge: knowledgeable	3.43	<.001*	30.87	8.22	156.76

Table 7-7: Greeting Behavioral Change Score

Coefficients	**Estimate (β)**	**P value**	**Odds Ratio**	**95% Confidence Interval**	
(Intercept)	-20.72	1.00	0.00	0.00	16.51
Location (>10km from bushmeat market)	0.95	0.32	2.57	0.40	3.42
NGO/MOH visits (>1 NGO/MOH visit)	-0.61	0.52	0.55	0.09	2.49
Animist (practicing)	-0.46	0.51	0.63	0.16	3.34
Education (at least some elementary school)	0.32	0.47	1.38	0.57	
Knowledge: informed	-1.02	1.00	0.36	0.00	
Knowledge: knowledgeable	20.50	1.00	803411100.00	0.00	
Location difference* >1 NGO/MOH visit	1.75	0.22	5.74	0.36	91.98

Table 7-8: Travel Behavioral Change Score

Coefficients	Estimate (β)	P value	Odds Ratio	95% Confidence Interval	
(Intercept)	-19.17	0.99	0.00	0.00	3.89
Location (>10km from bushmeat market)	-0.58	0.56	0.56	0.08	2.71
NGO/MOH visits (>1 NGO/MOH visit)	-0.91	0.35	0.40	0.06	3.41
Animist (practicing)	0.00	1.00	1.00	0.29	1.65
Education (at least some elementary school)	-0.30	0.46	0.74	0.33	Inf.
Knowledge: informed	17.49	0.99	39414280.00	0.00	Inf.
Knowledge: knowledgeable	18.55	0.99	113259300.00	0.00	104.71
Location difference* >1 NGO/MOH visit	2.03	0.13	7.62	0.55	

Table 7-9: Hygiene Behavioral Change Score

Coefficients	**Estimate (β)**	**P value**	**Odds Ratio**	**95% Confidence Interval**	
(Intercept)	-1.67	0.02*	0.19	0.04	0.80
Location (>10km from bushmeat market)	-1.31	0.11	0.27	0.05	1.36
NGO/MOH visit visits (>1 NGO/MOH visit)	-2.55	<.001*	0.08	0.02	0.40
Animist (practicing)	0.93	0.10	2.53	0.84	7.56
Education (at least some elementary school)	0.09	0.82	1.09	0.52	2.29
Knowledge: informed	4.08	<.001*	59.37	8.76	402.21
Knowledge: knowledgeable	1.80	0.03*	6.08	1.23	29.97
Location difference* >1 NGO/MOH visit	2.56	0.02*	12.92	1.39	120.27

Table 7-10: Hygiene Behavioral Score with Location Effects and Multiple NGO/MOH Visits

Coefficients	**Estimate (β)**	**P value**	**Odds Ratio**	**95% Confidence Interval**	
(Intercept)	-1.67	0.02	0.19	1.37	108.11
Location (>10km from bushmeat market)	-1.31	0.11	0.27	0.00	0.71
> 1NGO/MOH visit* <10km to bushmeat	-2.55	0.00	0.08	0.00	0.60
> 1NGO/MOH visit*>10km from bushmeat	0.01	0.99	1.01	0.60	41.65
Animist (practicing)	0.93	0.10	2.53	0.25	5.27
Education (at least some elementary school)	0.09	0.82	1.09	0.57	62.36
Knowledge: informed	4.08	0.00	59.37	0.00	Inf.
Knowledge: knowledgeable	1.80	0.03	6.08	0.37	9.16

1.7.2 Zoonotic Sub-Score Analysis

Table 7-11: Zoonotic Behavioral Change Score

Coefficients	**Estimate (β)**	**P value**	**Odds Ratio**	**95% Confidence Interval**	
(Intercept)	1.18	0.07	3.26	0.91	11.72
Location (>10km from bushmeat market)	-2.52	0.01*	0.08	0.01	0.48
NGO/MOH visits (>1 NGO/MOH visit)	-3.13	<.001*	0.04	0.01	0.21
Animist (practicing)	1.40	0.02*	4.06	1.26	13.13
Education (at least some elementary school)	0.34	0.37	1.41	0.67	2.96
Knowledge: informed	-1.70	0.04*	0.18	0.04	0.91
Knowledge: knowledgeable	-1.49	0.03*	0.22	0.06	0.87
Location difference* >1 NGO/MOH visit	3.84	<.001*	46.55	3.60	601.90

Table 7-12: Bushmeat Behavioral Change

Coefficients	Estimate (β)	P value	Odds Ratio	95% Confidence Interval	
(Intercept)	-1.92	0.02*	0.15	0.03	0.72
Location (>10km from bushmeat market)	-2.58	0.01*	0.08	0.01	0.53
NGO/MOH visits (>1 NGO/MOH visit)	-3.38	<.001*	0.03	0.00	0.23
Animist (practicing)	1.72	0.01*	5.60	1.41	22.27
Education (at least some elementary school)	0.33	0.46	1.40	0.57	3.41
Knowledge: informed	1.57	0.12	4.81	0.67	34.81
Knowledge: knowledgeable	1.73	0.06	5.62	0.94	33.56
Location difference* >1 NGO/MOH visit	3.37	0.02*	29.09	1.70	496.74

Table 7-13: Bushmeat Behavioral Change with Location Effects and Multiple NGO/MOH Visits

Coefficients	Estimate (β)	P value	Odds Ratio	95% Confidence Interval	
(Intercept)	-1.92	0.02*	0.15	0.03	0.72
Location (>10km from bushmeat market)	-2.58	0.001*	0.08	0.01	0.53
> 1NGO/MOH visit*<10km to bushmeat	-3.38	<.001*	0.03	0.00	0.23
> 1NGO/MOH visit * >10km from bushmeat	-0.01	0.99	0.99	0.13	7.59
Animist (practicing)	1.72	0.01*	5.60	1.41	22.27
Education (at least some elementary school)	0.33	0.46	1.40	0.57	3.41
Knowledge: informed	1.57	0.12	4.81	0.67	34.81
Knowledge: knowledgeable	1.73	0.06	5.62	0.94	33.56

Table 7-14: Interaction with Wildlife Behavioral Change

Coefficients	Estimate (β)	P value	Odds Ratio	95% Confidence Interval	
(Intercept)	-0.21	0.78	0.81	0.19	3.46
Location (>10km from bushmeat market)	-1.00	0.50	0.37	0.02	6.82
NGO/MOH visits (>1 NGO/MOH visit)	-1.48	0.16	0.23	0.03	1.78
Animist (practicing)	0.52	0.58	1.67	0.27	10.47
Education (at least some elementary school)	0.43	0.60	1.54	0.30	7.82
Knowledge: informed	-38.74	1.00	0.00	0.00	
Knowledge: knowledgeable	-38.51	0.99	0.00	0.00	
Location difference* >1 NGO	20.68	1.00	957622500.00	0.00	

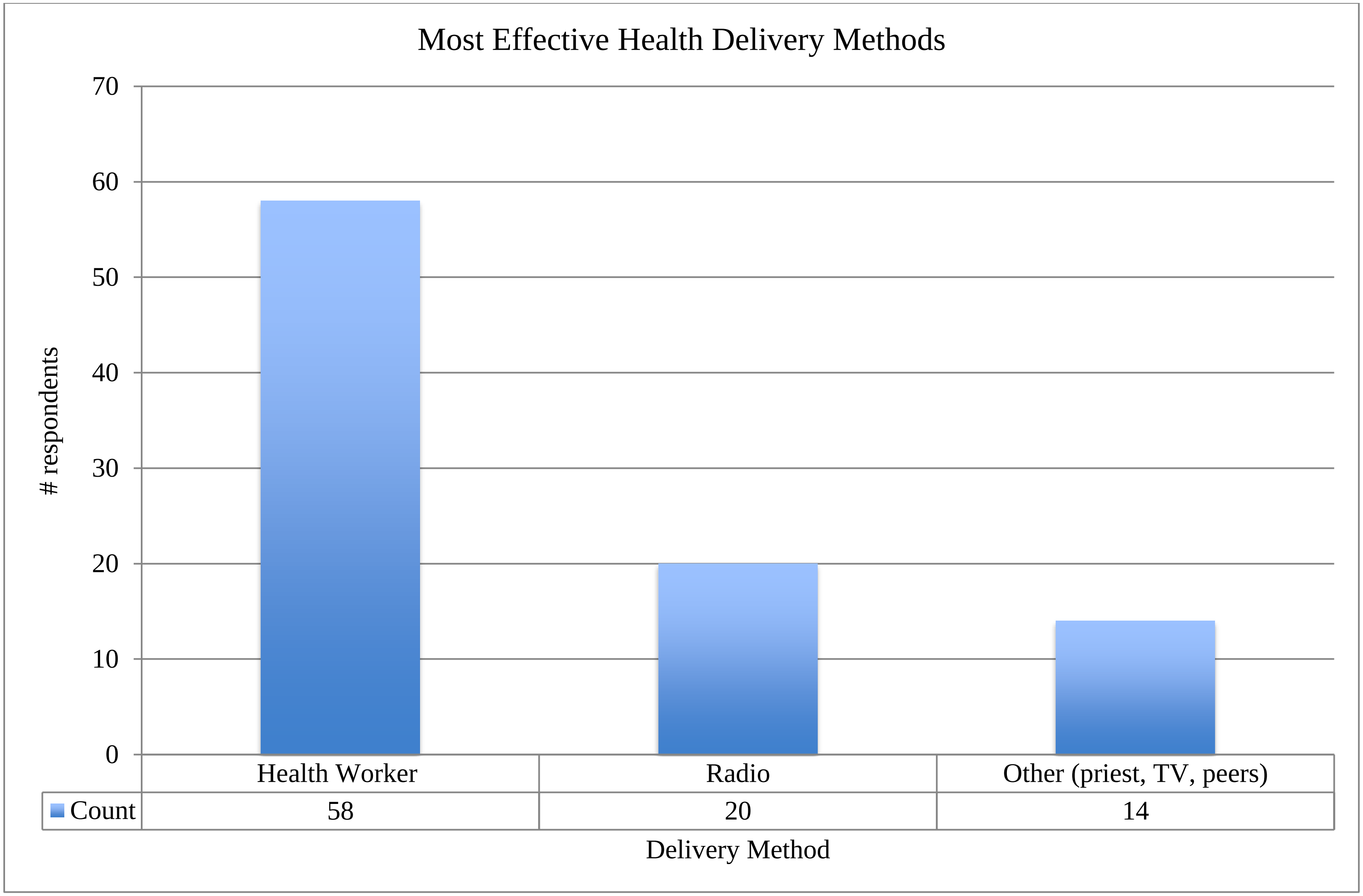

Figure 7-1: Most Effective Delivery Method for Health Message

7.4 Calculations for Inverse Logistic Regression Probability Estimates:

function(x) {1/(1+exp(-x))} applied to:

y=.6375-2.3356*(Far bushmeat)-3.5781*(NGO)+5.188*(Far bushmeat: NGO)

y=.6375-2.3356*(0)-3.5781*(0) +5.188*(0) =1 NGO close to bushmeat

y=.6375-2.3356*(1)-3.5781*(0) +5.188*(0) =1 NGO far to bushmeat

y=.6375-2.3356*(0)-3.5781*(1) +5.188*(0) = >1 NGO close to bushmeat

y=.6375-2.3356*(1)-3.5781*(1) +5.188*(1) => 1 NGO far to bushmeat

7.5 Description of NGOs and MOH Services

7.5.1 Croix Rouge (Red Cross)

Croix Rouge was supported by World Vision, a Christian NGO. It was located in Salemata and staffed by a youth group interested in health work and supervised by a health worker/nurse. Croix Rouge trainings promoted hygiene and discussed symptoms and causes of EBOV. Croix Rouge NGO trained high school students to visit villages that were accessible by car. They broadcasted EBOV health messages over a loud speaker in a central location. Their sensitization programs state that EBOV is contagions and there is no cure or vaccine. They promote regular hand washing, avoiding infected persons, recognizing signs and encouraging prompt medical attention. They further state avoid contact with wildlife and do not wash bodies during traditional burials. They have 163 volunteers in the Salemata and border regions. They failed to record the names of villages visited, dates, number of visits and attendance records. There were no follow-up evaluations regarding behavioral change or assessing villagers' comprehension of the health messages. They also promoted their health messages on the local Salemata radio in four local languages (Pular, Bassari, Jaxenca and French). Of the seven villages surveyed they visited two. They reported training 1,778 people (300 homes) in the Bassari region during September-November 2014. They projected a second training to begin in March 2015 but it had not started as of July 2015.

7.5.2 Caritas

Caritas is an international Catholic NGO with 50 health workers in the Salemata region. For each village, they provided a hand washing kit, which included bleach, soap, a plastic basin and a washing kettle. They did not replenish soap or bleach supplies and did not train communities members how to make their own soap from available resources such as peanuts or honey. Bleach dilution techniques were taught however bleach safety was not discussed and posed a risk in communities where bleach is easily accessible by children. Their work did not begin until February 2015, 13 months after the first case of EBOV in Guinea. CHWs were paid based on the number of villages and people trained but there was little accountability and supervision. In July 2015, Caritas supervisor discovered a number of falsified records by CHWs that reported completed trainings and attendance sheets in villages they never visited.

7.5.3 Sadev and Mundu de

NGO's Sadev, a Swedish NGO, and Munde de had a minimal presence in Bassari country and were slow to implement any health campaigns. They began work in the area in March of 2015; over 14 months after the outbreak began. They sent CHWs to a few Bassari villages and promoted improved hygiene by installing hand-washing stations (tip-tap) using locally sources materials. They appeared to abandon the project mid-way, leaving many villagers feeling slighted due to inconsistent distribution of hand washing stations.

7.5.4 Ministry of Health

The Ministry of Health (MOH) developed national trainings and worked closely with NGOs. MOH and Social Action, a department within the Senegalese government, managed the distribution and hierarchy of health systems. The MOH in collaboration with USAID created educational radio campaigns in local languages promoting increased hygiene, vigilance and cessation of bushmeat consumption. They identified the symptoms of EBOV and focused on avoiding bodily fluids of infected persons, especially during burial practices. They encouraged people to seek medical attention if symptomatic.

Agent de Sante Communautaire (ASC) (Community Health Agent)) were sent my MOH to Bassari villages to speak to the chief of the village and to educate individuals while conducting malaria screening. In June 2013, MOH began a new house-to-house malaria screening that involved an ASC weekly visiting remote villages to screen febrile persons for malaria. They drew a drop of blood for a rapid malaria test, provided malaria treatment as needed and referred severe cases to the Salemata health facility. ASC received additional training, on identifying EBOV patients since the symptoms of EBOV and malaria presented very similarly: fever, diarrhea, vomiting and lethargy. During this time they were not provided protective equipment such as gloves or medical disposal devices for sharps and blood products. The ASC continued screening for malaria during the EBOV epidemic even after Peace Corps volunteers, who supervised the ASC on the ground, were asked by the US government to terminate their involvement.

7.5.5 Yaajeende

Yaajeende is a locally staffed United States Agency of International Development (USAID) program that works on the management of natural resources and food security. In response to the EBOV outbreak, USAID and Yaajeende trained CHWs on prevention of human-to-human EBOV transmission. Their trainings promoted hygiene and discussed symptoms and causes of EBOV.

7.6 Interview Questions

Questions addressed to NGO supervisors:

Can you please tell me where you have held Ebola health campaigns around Salemata? Which Bassari villages? How many times did you visit that village? When? What information did you cover? Did you distribute any materials or provide any goods? Explain.

To community leaders:

Which NGOs have visited here to train your community about Ebola? When? How many times?

7.7 Survey

Pre-survey Introductions:

My research strives to evaluate the effectiveness of Ebola health campaigns to help prevent a future Ebola outbreak. The surveys are optional. The surveys will be anonymous. Your village name and your name will not be recorded. The results will be shared with Non-governmental organizations and ministry of health so they can improve their health campaigns. There will be no legal ramifications for sharing information concerning hunting practices or interactions with wildlife. I am trying to understand how to protect Bassari culture and wildlife while preventing Ebola in Senegal. I hope you cooperate and answer my questions honestly.

Interviewee :…………………	Date: …………………………… ………..	Village Name: …………………………… …………
Start Time:………..	End Time:………………….	Sex F M
Name of Interviewer: …………………………… …	Notes: ……………………………………………………………… ……………………	

1. Age
    a. 18-25
    b. 26-35
    c. 36-45
    d. 46-55
    e. >60
2. Ethnicity
    a. Bassari
    b. Pular
    c. Bedik
    d. Other
3. Religion
    a. Animalist
    b. Muslim
    c. Other: specify

3i. Do you have any animalistic offerings or sacrifices in your home?
Yes No

4. Education level
    a. Less than primary school
    b. Some elementary school
    c. Some middle
    d. Some high school
    e. some university
5. How long have you lived in this village?
    a. All my life
    b. >20 years
    c. 10-20year
    d. 10-5 years
    e. <5 years
6. What do you do for work?
    a. Farmer
    b. Vendor
    c. Teacher
    d. Health worker
    e. Pastoralist
    f. Carpenter
    g. Monitor for school
    h. Other:
7. How far is your field from your home?
    a. <1km
    b. 2-4km
    c. 5-10km
    d. >10km
8. What types of crops do you cultivate?
    a. Corn
    b. Peanut
    c. Millet
    d. Fonio
    e. Beans
    f. Rice
    g. Cotton
    h. Ground nuts
9. Do you own a radio?
10. Have you heard any health campaigns discouraging bushmeat consumption?
    i. What source?
        a. Friend
        b. Radio: specify Salemata or Guinea
        c. health post
        d. Red Cross
        e. NGO

f. Health worker
g. Students
h. Chief
i. Teachers
j. Priest
k. other

11. Have you heard the radio health campaigns about preventing Ebola?

a. Avoid contact with infected person
b. hand washing/hygiene
c. Avoid bushmeat
d. Partial symptoms
e. I don't know
f. Dangerous disease/Ebola exists

a. What did you understand from listening to the radio concerning Ebola?

ii. Has their message to not interact with wildlife and do not consume bushmeat affected your behavior?

iii. Which message (NGO/MOH) has been most effective?

a. Red cross
b. Caritas
c. Salemata health District
d. Radio
e. Nuns
f. Relay
g. Teachers
h. Chief
i. Health post
j. Spouse
k. priest

12. What do you believe causes Ebola?

a. Bat
b. Baboon
c. Porcupine
d. All Bushmeat
e. I don't know
f. Going to infected areas
g. Grivet monkeys
h. chimpanzees

13. Has Ebola health campaigns changed or affected your behavior?

Yes No

ii. If yes, how?

a. Greeting
b. Bushmeat
c. Tourism

d. Hand washing/sanitation (wash fruit)
e. Feeding wildlife
f. Vaccinating cows
g. Other (clean home, clean water/food)

iii. If yes to bushmeat, what type of behavior has changed?
   a. Consumption
   b. Selling
   c. Butchering/cooking techniques
   d. Secretive behavior
   e. hunting

14. When did you experience this behavior change?
   a. Within first week of Ebola outbreak
   b. Last year
   c. After 6 months
   d. After 2 months
   e. Last month
   f. 1-3 weeks ago
   g. I don't know
   h. No change

15. Prior to Ebola in West Africa last year did you hunt, consume or butcher bushmeat more than now?
   i. How much more?
   ii. Before Ebola did you eat or hunt different animals than now? If so which ones?
      a. Baboon
      b. Patas
      c. Grivet
      d. Warthog
      e. Duiker
      f. Porcupine
      g. Rabbit
      h. Squirrel
      i. Eland
      j. Rats