



## Assessment of the Structural Effects of Ebola Disease Outbreak on Bush Meat Enterprise in Nigeria: Implications on Biodiversity Conservation

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### Authors' contributions

This work was carried out in collaboration between all authors. Author ANO designed the research study, wrote the protocol and supervised the final version of the manuscript and. Authors CPE performed the statistical analysis and wrote the first draft of the manuscript and author EJI conducted the literature review, interpreted, wrote and discussed the results of the data analysis in the discussion section. All authors read and approved the final manuscript.

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### ABSTRACT

**Aim:** The paper assesses the structural effects of Ebola disease outbreak on bush meat enterprise in Nigeria and its implication on biodiversity conservation.

**Study Design:** The study employs survey research approach.

**Place and Duration of Study:** Department of Agricultural Economics, University of Nigeria, Nsukka, between January 2016 and September 2016.

**Methodology:** Random sampling technique was used to select 100 respondents using structured questionnaires. Data was analyzed using descriptive statistics, multiple regression, and chow test.

**Results:** The result showed that there was a drop in the levels of sales and consumption of bush meat during the Ebola disease outbreak which lasted for three (3) months. However, bush meat sales and consumption returned to normal immediately Nigeria was declared Ebola Virus Disease (EVD) free. The regression's result pointed out that family size and income had significant and

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positive relationship with level of sales of bush meat. The Chow test also showed a structural change in the level of sales as a result of the Ebola outbreak.

**Conclusion:** It is posited that the structural change in the sales and consumption of bush meat as a result of Ebola disease outbreak presented a unique opportunity for stakeholders to formulate and implement policies that will engender forest faunal conservation in the country, through targeted investment in public education, policy implementation and awareness creation about the health and biodiversity effects of bush meat consumption.

*Keywords: Structural effect; Ebola disease virus; biodiversity conservation; bush meat; livelihood.*

## 1. INTRODUCTION

More often than not, the fear generated by many disease outbreaks usually escalates its intending consequences [1]. This is not uncommon in Nigeria, a country that has experienced several outbreaks of diseases in the last few decades. For instance, the incidence of cholera, yellow fever, Lassa fever and monkey pox outbreaks that has occurred in different parts of the country over the years has generated more panic that goes beyond health implications to affect other socioeconomic life of the people such as social interaction, consumption pattern, and business activities. For instance, [2] reported how the Lassa fever outbreak led to civil unrest, migration, disruption of agricultural cycles and reduction in farming activities. Similarly, [3] found that the Cholera disease outbreak posed grave risks to pregnant women especially in conflict-affected areas of Nigeria. Similar social effects have been noticed in the case of Ebola Virus Disease (EVD) outbreak in West Africa in 2014. Akani et al. [4] for example noted that although there were recorded cases of individuals who contracted the virus – with some reported deaths in some parts of the country like Lagos and Port Harcourt. The hype generated by the incidence was so enormous that it affected different facets of the socioeconomic and cultural lives of Nigerians. One of the major socioeconomic and cultural activities affected by the Ebola disease outbreak in Nigeria is the bush meat enterprise.

Bush meat, the meat of wild animals, is one of the most valuable tropical forest products after timber and serves as an important source of protein, widely consumed in both rural and urban areas [5]. The magnitude of its exploitation and consumption, however, varies from one place to the other and it is determined principally by its availability [6] as well as government control on hunting, socio economic status and cultural prohibitions [7]. National estimates of the value of the domestic trade in bushmeat range from US\$42 to US\$205 million across countries in

West and Central Africa [8] Bush meat enterprise, which involves hunting, marketing, and consumption of wild animals, is one of the major sources of livelihoods for rural dwellers, especially forest dependent communities [9].

Wildlife has been hunted for food ever since human race evolved, and bush meat is still viewed as a resource “free-for-the-taking” in many areas of Africa. The meat provides an important source of protein in both rural and urban household diets [10]. Thus, the volume of bush meat consumed in most Nigerian cities is assuming a threatening dimension that urgent measures need be taken to stem the tide. Essentially, wildlife hunting is mostly promoted and driven by the ready-made market provided by the urban elites who have the financial muscle to purchase bush meat at almost three times the price of conventional animal meats [11]. The meat is usually consumed more in restaurants or “pepper-soup joints” by most people than in their homes. The attractive market provided by the cities for bush meat has therefore changed the dimension of wildlife hunting from subsistence to commercial hunting, where hunters kill just anything to meet family protein needs and also generate income [10]. By so doing, some very rare species such as Dama Gazelle, pangoline, antelopes, grasscutters, deer, bush dogs, bush rats, etc are gradually going extinct.

The situation seems unchallenged due to the fact that the enterprise has long served as a major contributor to the food security of millions of people across the developing world, most notably in Africa, Latin America and Asia [12]. A study carried out by Bowen-Jones et al. [11] showed that bush meat trade is a large contributor to the economies of West and Central African countries by having significant impact on the livelihoods of the rural people as a source of income. It has also contributed to the economy of most rural people living at the margins of the cash economy that have very limited options for generating income as they often lack the capital to invest in livestock husbandry, as well as the

education and skills to find suitable and permanent [13].

Thus, even where bush meat is utilized to meet basic needs, many communities also rely on hunting to supplement their short-term cash requirements, with the distinction between subsistence and commercial use often being blurred [12]. For them, bush meat sale affords a means to purchase items and materials that a subsistence lifestyle does not provide. For some, the trade in bush meat can represent a full-time source of income, while for others this may serve as a buffer during times of hardship (e.g. crop failure, unemployment, illness of relatives) or as a means to generate extra cash for special needs (school fees, funerals [14]. Furthermore, recent studies on bush meat preference indicate that urban dwellers seem to be exerting more demand-pull on bush meat consumption than rural dwellers [4,9,15]. Several reasons have been given for this. For instance, [15] noted that the unique taste of bush meat as well as the social class associated with its consumption is major drivers of bush meat consumption in West Africa. Dindé [9] posited that many people are going back to the old habit of bush meat consumption due to the cultural taste it provides. Akani et al. [4] on the other hand associated the high demand for bush meat consumption among urban dwellers to the nutritional value of low caloric of the meat compared to conventional meat.

However, the outbreak of Ebola disease in 2014 has upset the bush meat enterprise, hence the fall in the demand of the product by majority of the consumers during the outbreak. This is as a result of the popular narrative that Ebola disease originated from bushmeat consumption [16]. As a result, both government and non-governmental bodies joined the campaign against the disease by creating awareness amongst the citizens, including the avoidance of bush meat consumption, which has been identified as the major means of the spread of the virus. As expected, this led to a decline in the consumption of bush meat around the country, even in areas where there was no incidence of the virus, making the bush meat enterprise to suffer deterioration in sales [17]. It was on this premise that this study was born to assess the structural effect of Ebola disease outbreak on the bush meat enterprise in Nigeria. This is in order to evaluate whether the outbreak provided a veritable nexus for the conservation of forest fauna in the country or not. Although some

studies have been carried out to assess the socioeconomic impact of the Ebola virus disease in different parts of Africa [4,18,19], little has been done to assess its structural effect on bush meat enterprise in Nigeria. The little available literature on the subject such [4,6,17,20] did not explore its nexus with forest conservation, together with other implications on rural livelihoods and new direction for public campaign on fauna conservation.

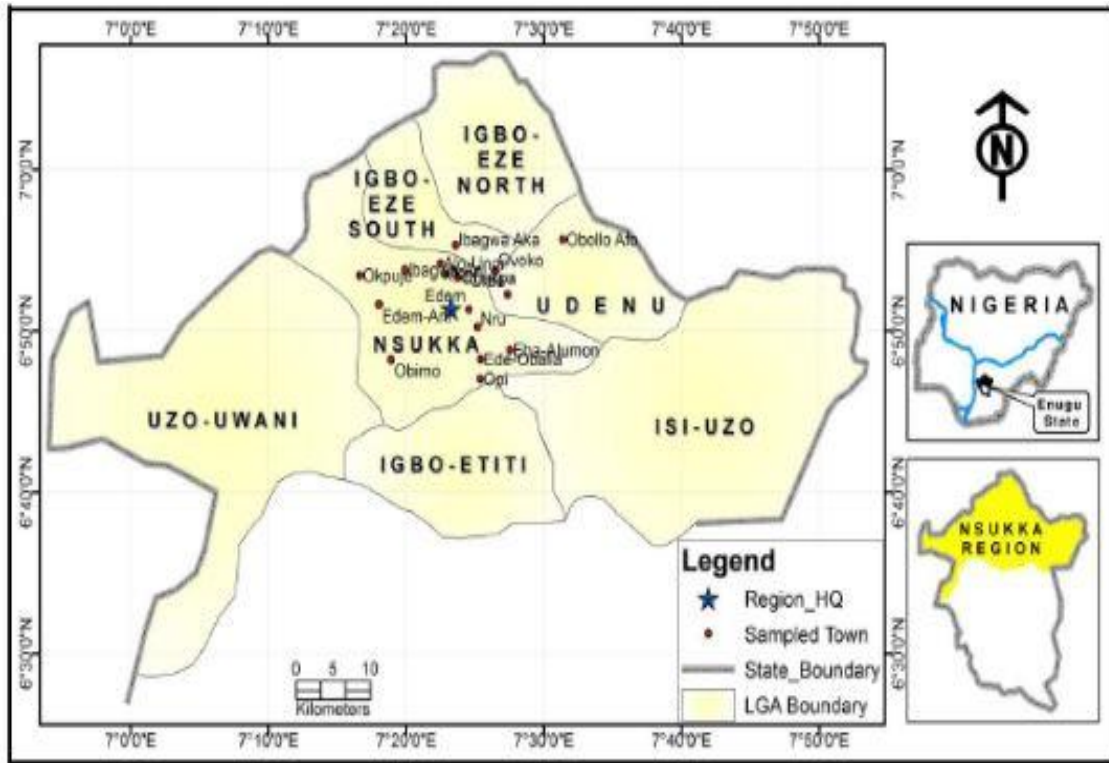
## 2. METHODOLOGY

### 2.1 Study Area

This study was conducted in Nigeria. Nsukka Agricultural Zone of Enugu State was particularly chosen for the study due the large concentration of bush meat enterprises and consumers in the rural, urban and semi urban environment of the area. The agricultural zone is made up of three local government areas (LGAs) namely: Nsukka, Igboetiti and Uzo Uwani Local Government Areas [21] Rainfall distribution is between 168mm – 1700 mm. The area has tropical climates marked by two distinct seasons; the rainy and dry seasons, which favour the thriving of different kinds of wild animals. The vegetation is derived of savannah, and people in this area are predominately farmers who also combine farming with hunting. However, some of the urban areas like Nsukka town have more civil servants and traders who patronize the vibrant bush meat outlets. The area has a high concentration of chop bars, eateries and restaurant where bush meat is sold. Popular bush meats found in the area include pangoline, antelopes, grasscutters, deer, bush dogs, and bush rats. The EVD which spread in Nigeria between 20<sup>th</sup> July 2014 and 20<sup>th</sup> October 2014 (three months) had affected the sale and consumption of these bush meats.

### 2.2 Sampling Procedure, Data Collection

Multistage sampling technique was adopted in the selection of respondents. The technique involves taking of samples in stages using smaller and smaller sampling units at each stage. It is considered appropriate for this study because of its effectiveness in collecting primary data from geographically dispersed population such as Nsukka Agricultural zone. Furthermore, the technique has the advantage of flexibility, time and cost effectiveness in primary data collection [22]. Out of the three LGAs in the zone, two were randomly selected: Nsukka and



**Fig. 1. Map of Nsukka Agro-ecological zone showing Nsukka and Igbo Etiti sampled areas**

*Source: Department of Geography, University of Nigeria, Nsukka*

Igboetiti. From each of the selected LGAs, 20 bush meat sellers were randomly selected from the list of sellers from the bushmeat Trade Union, making a sample of 40 bush meat sellers, while 30 of their customers (consumers) were also selected from each of the LGAs, giving a total of 60 consumers.

Primary data for the study were collected using semi-structured questionnaires. This data collection tool is considered appropriate for the study because it offers an objective means of collecting information about people's knowledge, beliefs, attitudes, and behaviour [23]. In addition, the semi-structured nature of the questionnaires provides the opportunity for both open and closed-ended questions while the closed-ended questions provides the opportunity to elicit specific responses from respondents, the open-ended questions gives the respondents more flexible opportunity to express their views. Two sets of questionnaires were structured for both the sellers and the consumers. The questionnaire contained information on the respondent's socioeconomic characteristics, perceived causes of Ebola outbreak, risk

behaviors, level of sales and consumption before, during and after the Ebola outbreak.

Since the study relies on primary data collected by issuing questionnaires to respondents, two ethical issues were considered. They are concerns about consent and confidentiality. To handle this, a voluntary informed consent form was designed by the researcher and signed by all the respondents who participated in the study, wherein the researcher explained the details and purpose of the research, and ensured the participants that the exercise was strictly for academic purposes, hence anonymity and confidentiality of information will be respected.

### 2.3 Data Analysis

Data was analyzed using descriptive statistics, multiple regression analysis and chow test.

### 2.4 Multiple Regression Analysis

The multiple regression analysis is an econometric tool of analysis used in determining the effects of one variable (independent) on the other (dependent) [24]. Several authors have

adopted the model to examine how changes in the independent variables affect the dependent variable. Chow [25] for instance, employed the multiple regression analysis in the study of the effects of tropical deforestation in Rondonia, Brazil. The socioeconomic characteristics of the household used include average age, education level of the household heads, farming experience and household size. These variables were used to determine the households' land use in Rondonia. In this study, the model was used to measure the changes in sales and consumption volumes (Ys) as a result of changes in various socioeconomic variable ( $X_1, X_2, X_3, \dots, X_n$ ).

The three functional forms (linear, semi logarithmic and double logarithmic) were ran for the study and the one of best fit was chosen. The three forms are represented as follows:

i. Linear form:

$$Y_c = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + e$$

ii. Semilog form:

$$\log Y_c = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + e$$

iii. Double log form:

$$\log Y_c = b_0 + \log b_1X_1 + \log b_2X_2 + \log b_3X_3 + \log b_4X_4 + \log b_5X_5 + \log b_6X_6 + \log b_7X_7 + e$$

Where:

Ys = Sales volume  
 X1= Age of respondents  
 X2= Sex of respondents  
 X3= Level of education  
 X4 = Family size  
 X5= years of experience in the trade  
 X6= Monthly income.  
 X7 = Marital status  
 e = Stochastic error term

## 2.5 Chow Test

The Chow test is best used to examine structural breaks or changes in a model [26]. Bausch and Schwarz [27] employed the tool to test for structural breaks in the GDP of US data. In this study, Chow test was used to test for the significant difference between the sales volume before and during the Ebola outbreak. If F-cal is greater than F-tab, it then indicates that there was a structural change in the volume of sales.

This was used to test the hypothesis of the Ebola outbreak having an effect on bush meat enterprise. The model is specified as follows:

$$F\text{-chow} = \frac{(R_{xx} - R_{xx1} + R_{xx2}) / k}{R_{xx1} + R_{xx2} / N - 2K}$$

Where:

$R_{xx}$  = Residual sum of square for the pooled sample (combination of sales before and during)

$R_{xx1}$  = Residual sum of squares from the regression of sales before the Ebola outbreak

$R_{xx2}$  = Residual sum of squares from the regression of sales during the Ebola outbreak

N = Total number sampled

K = Number of parameters

## 3. RESULTS

### 3.1 Socio-economic Characteristics of Respondents

The analysis of socioeconomic characteristics was done using relevant variables. These include age, gender, marital status, family size, level of education, monthly income and year of experience in the bush meat trade. The result of this analysis is presented in Table 1.

The results of the analysis on gender indicates that the majority of the population that indulge in the selling of bushmeat at the restaurants are females (57.5%) while majority of the males consume bushmeat (66.7%). Analysis on respondents' age shows that it was mostly people within the age range of 41-50 (40%) that indulge in the business of selling bushmeat followed by people within the age range of 21-30(10%). Meanwhile, the population of sellers having a mean age of 44.18 indicates that most of the sellers are still in their active age. The opposite was the case in the area of consumption as over half the population (53.3%) was majorly people within the age range of 21-30. Marital Status results show that most of the respondents that are sellers (87.5%) were married while the rest of them (12.5%) were single. For the consumers, it shows that the majority were single (55.5%). Result on level of education shows that majority of the bushmeat sellers spent a range of 10-12 years in school (42.5%) and this bracket of years shows those that had their secondary school education. Only

a small percentage (5%) of them had no formal education. A greater percentage of the consumers lie between the people that spent 10-12 years in school (41.7%) and 12-17 years (26.7). In terms of family size, the result revealed that 57.5% of the respondents that are sellers had 6-10 people in their household, while 42.5% had less than 6 people in their household. For the consumers, majority of them have a household size of 1-5(75%), and those with household higher than that have lower

percentage (25%). Concerning years of experience in bushmeat trade, most of the respondent (72.5%) have spent more than 10 years in the bush meat trade, and only 27.5% have spent 10 years and below. Monthly income result shows that both the sellers and consumers have a moderate to high range of monthly income (N51, 000 - N101, 000). A higher percentage of the sellers have monthly income within the ranges of N50, 000 and above.

**Table 1. Socioeconomic characteristics of respondents**

Variable	Sellers		Consumers	
	Frequency	Percent	Frequency	Percent
<b>Gender</b>				
Male	17	42.5	40	66.7
Female	23	57.5	20	33.3
Total	40	100.0	100	100.0
<b>Age</b>				
21-30	4	10.0	32	53.3
31-40	10	25.0	20	33.3
41-50	16	40.0	4	6.7
51 and above	10	25.0	4	6.7
Total	40	100.0	60	100.0
<b>Marital status</b>				
Single	5	12.5	33	55.5
Married	35	87.5	21	35.5
Divorced	0	0.0	0	0.0
Widowed	0	0.0	6	10.0
Total	40	100.0	60	100.0
<b>Years spent in school</b>				
No formal education	2	5.0	0	0.0
1-6 years	16	40.0	16	26.7
7-9 years	1	2.5	1	1.7
10-12 years	17	42.5	25	41.7
12-17	3	7.5	16	26.7
17-30	1	2.5	2	3.3
Total	40	100.0	60	100.0
<b>Family size</b>				
1-5	17	42.5	45	75.0
6-10	23	57.5	15	25.0
Total	40	100.0	60	100.0
<b>Years of bushmeat selling experience</b>				
1-5	4	10.0		
6-10	7	17.5		
11-15	10	25.0		
16 and above	19	47.5		
Total	40	100.0		
<b>Monthly income</b>				
N 1000-10000	0	0.0	1	1.7
N 11000-50000	0	0.0	30	50.0
N51000-100000	1	2.5	20	33.3
> N 101000	39	97.5	9	15.0
Total	40	100.0	60	100.0

Source: Field survey, 2016

### 3.2 Level of Reduction in Sales and Consumption during the Ebola Outbreak

The sellers and consumers were asked if there was any reduction in the level of sales and consumption respectively. The result of their responses is presented in Tables 2 and 3. While Table 2 shows the level of reduction in sales and consumption of bush meat during Ebola outbreak, Table 3 presents the mean monthly sales and consumption before, during and after the Ebola outbreak. With the incidence of the outbreak, out of the 40 sellers that were interviewed, as shown by the result, 31 affirmed that their level of sales reduced to an extent during the outbreak. Table 2 also showed that 55% of the consumers affirmed that their level of consumption dropped during the outbreak. The results in Table 2 show that though there was a drop in the sales and consumption of bush meat during the EVD outbreak, the situation became normal again just after the EVD scare.

### 3.3 Structural Changes in the Level of Sales

The result of the perceptions of the respondents above clearly indicates that there was a perceived drop in the sales and consumption of bush meat, it became necessary to statistically test the result to show if the reduction was by chance or a result of the outbreak of the EVD. Thus, a Chow test was run. For the Chow test to be conducted, the residual sum of squares from the regression of sales before, during and the combination of sales before and during (pooled) were used. Thus, the three functional forms were

run for this analysis (linear, semi log and double log), and the model of the best fit was chosen based on the following criteria: size of  $R^2$ , apriori expectations of the size and sign of the variables and number of significant variables. The regression results are as shown in Table 4.

The results of the regression showed that family size had a significant but negative effect on sales. This indicates that a 50.0 unit increase in family size leads to a 50.0 unit decrease in the volume of sales.

Chow test was used to test for the following hypothesis:

$H_0$  = There was no structural change in the level of sales of bushmeat before and during the EVD outbreak.

$H_a$  = There was a structural change in the level of sales.

To test this, the residual sums of squares of the chosen functions were used to run the Chow test. Infusing those figures into equation 1, we got an F-Chow with the value 14.76. It was then compared with F-tab at 5%,  $F(8, 80)$  whose value was 2.06. Thus, since the  $F_{cal} > F_{tab}$ , we reject the null hypothesis which states that there were no structural change in the level of sales and accept the  $H_a$  that there was actually a structural change in the level of sales of bush meat, and this could be attributable to the incidence of the Ebola outbreak. From this result, we can strongly infer that the Ebola Virus Disease outbreak really had an effect on the level of sales of bush meat and thus on the bush meat enterprise in Nigeria.

**Table 2. Level of reduction in sales and consumption during the Ebola outbreak**

#### Sellers' response to drop in sales

	Frequency	Percentage
Reduction in sales	31	77.5
No reduction in sales	9	22.5
Total	40	100.0

#### Consumers' response to drop in their level of consumption

	Frequency	Percentage
Reduction in consumption	33	55.0
No reduction in consumption	27	45.0
Total	60	100.0

Source: Field survey, 2016

**Table 3. Mean monthly sales and consumption before, during and after the Ebola outbreak**

	Sales (no of plates of bush meat sold in a month)			Consumption (frequency of consumption in a month)		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Before Ebola Outbreak	150	6000	1762.50	2.0	50.0	12.283
During Ebola outbreak	0	4500	868.50	0.0	60.0	8.233
After Ebola outbreak	0	5100	1631.00	0.0	50.0	11.833

Source: Field survey, 2016

**Table 4. Regression results showing the relationship between socioeconomic characteristics of respondents and sales of bush meat**

**Before the Ebola disease outbreak**

Variables	Linear		Semi log		Double log	
	Coefficient	p> t	Coefficient	p> t	Coefficient	p> t
Sales volume						
Sex	256.1293	0.635	290.5049	0.560	-0.0687	0.840
Age	29.6191	0.389	2950.0640	0.084	0.8005	0.485
Marital status	511.6804	0.451	831.8572	0.373	0.1263	0.843
Years spent in school	-45.6892	0.330	-1173.668	0.058	-0.8900	0.037
Family size	-190.4088	0.102	-1377.999	0.019	-0.5009	0.200
Years of experience	-18.7909	0.486	-685.9336	0.060	-0.4204	0.091
Monthly income	0.0001	0.271	66.4904	0.787	-0.0664	0.694
Constant	1013.99	0.641	-4184.477	0.494	8.9653	0.039
R-squared	0.0785		0.3343		0.2297	
Residual SS	25.4129		37442300.4		17.6021	

**During the Ebola disease outbreak**

Variables	Linear		Semi log		Double log	
	Coefficient	p> t	Coefficient	p> t	Coefficient	p> t
Sales volume						
Sex	472.0984	0.414	0.1246	0.730	0.2137	0.492
Age	-0.8806	0.981	0.0007	0.975	-0.6041	0.562
Marital status	73.9849	0.918	0.1205	0.788	0.2405	0.42
Years spent in school	-21.2589	0.670	-0.1257	0.687	0.1092	0.29
Family size	-124.9096	0.309	-0.1035	0.177	0.0066	0.02
Years of experience	26.723	0.354	0.0156	0.389	0.0806	0.36
Monthly income	0.0001	0.356	0.0000	0.320	0.4790	2.98
Constant	1640.864	0.481	7.2327	0.000	2.3423	0.61
R-squared	0.1532		0.1658		0.3451	
Residual SS	54420700.2		19.5105		13.3426	

**Before and during the outbreak**

Variables	Linear		Semi log		Double log	
	Coefficient	p> t	Coefficient	p> t	Coefficient	p> t
Sex	364.1114	0.135	341.5962	0.355	0.0578	0.801
Age	14.3692	0.832	671.7776	0.587	0.1252	0.871
Marital status	292.8327	0.051	523.8738	0.447	0.1929	0.653
Years spent in school	-33.4741	0.305	-365.6056	0.413	-0.4162	0.140
Family size	-157.6592	0.536	-567.4872	0.176	-0.2631	0.313
Years of experience	3.9660	0.548	-169.4683	0.519	-0.1838	0.270
Monthly income	0.0001	0.334	392.9748	0.034	0.1855	0.115
Constant	1327.427	0.382	-4364.322	0.355	5.9628	0.039
Prob> F	0.1214		0.0226		0.0526	
R-squared	0.1422		0.2065		0.1841	
Residual SS	105567417		94119475.8		35.266035	

Source: Field survey, 2016



## 4. DISCUSSION

The overall result of the effect of Ebola disease outbreak on bush meat enterprise in Nigeria shows a structural reduction both in the sales and in the consumption. This finding is consistent with several previous studies conducted on the effect of the Ebola disease in different parts of West Africa which shows a dramatic drop in the consumption of bush meat (see for example [4,6,17,20,28,29]. Mutasand [30] noted that the Centre for Disease Control and Prevention in Nigeria, have associated human diseases with the processing and eating of infected bush meat. The implication of this incidence is discussed under three emerging areas: rural livelihoods, biodiversity conservation, and educational campaigns.

### 4.1 Implications for Rural Livelihoods

According to Akani et al. [4] bush meat is no longer a cheap subsistence meat for the poor who dependent on it for their protein needs, but now a delicious classy meal for the wealthy class who cherish its traditional taste. For the poor hunters and restaurant marketers, it has become a very big source of income [20]. The result of bushmeat sellers' income shows that a higher percentage of them have monthly income within the ranges of N50, 000 and above, implying that the business is profitable, giving them enough profit to even plough back into the business. However, since the outbreak of the Ebola disease, several owners of local restaurants in different parts of Nigeria lamented that the nation's health officials advised Nigerians against the consumption of bushmeat. Following the outbreak of Ebola disease, their take home has become abysmally low. In Calabar, Rohwerder [18] reported that consumers hardly patronize again, and even when they do, patronage is low. Some of the sellers complained that the use of hand gloves in the preparation of the delicacy as was prescribed by the health officials tends to discomfort them and affect the taste of the food. This is because, unlike the westerners who fry most of their meals or eat canned foods, Nigerians prefer cooked meals [31] and the preparation process usually requires a lot of washing, pounding and feeling, to know when it is ready to be cooked or eaten— things that cannot be done effectively wearing gloves. Bush meat business was also found to provide livelihood opportunities for women. The results of gender analysis in Table 1 indicates that the majority of the population that indulge in the

selling of bushmeat at the restaurants are females (57.5%) while majority of the males consume bushmeat (66.7%). This dominating scenario in the selling of bush meat by the females may be due to the rigorous processes involved in the cooking and processing of the bush meat in order to make it palatable, which in the culture of the study area was seen mainly as a woman's work – and just few men can venture into it. In the aspect of the consumption, because the data was collected at the bush bars, it is mostly men that patronize the bush bars where they relax from the day's work. Furthermore, data on family size (Table 1) revealed that bush meat sellers have relatively large family size. The reason for this could be that the bushmeat business requires more hands in cooking, processing, and selling, as there may be many customers to attend to at a time. For the consumers, majority of them have smaller households size. This may be due to the high cost of bush meat, with only those of lower household size being able to afford it as a source of protein.

Owners of restaurant also expressed their fear about receiving money from customers. Since Nigeria has not gone fully cashless, currencies must continue to change hands. Body contact cannot be completely ruled out as scores of people also go to the market every day to buy their needs [29]. Thus, sellers were scared of receiving payments in cash, while buyers feared that the food they were eating may not be completely safe from Ebola fluids. Obiukwu [32] report that beer parlor and food canteen operators in Ado-Ekiti experienced low patronage as bush meat sales reduced drastically since the news of Ebola virus outbreak became an issue in the country. This is because beer consumption goes along with eating of bush meat; many people don't drink beer without eating meat alongside. According to the report, few customers vowed to continue eating the meat, while majority said they will not risk eating it until medical experts gave contrary directives on the virus. Further reports show that the amount of money made from selling bush meat per day declined from N15,000 to N2,000 [33]. The length of time taken to sell bush meat was not also left out. Ndem et al. [17] reported that it was then taking an average of six days to finish selling the quantity of bush meat usually sold in one day due to low patronage.

Hunters are not left out of this effect of the Ebola disease outbreak. According to Adefalu et al.

[10], several hunters lamented the low patronage occasioned by the news of the Ebola virus outbreak irrespective of the price cut in the cost of bush meat. In Abeokuta, Ogun State, Obiukwu [32] noted that "... the once thriving business of bushmeat hunting is now in shambles as a result of the Ebola disease outbreak. Hunters are now afraid of hunting wildlife for fear of contracting the deadly Ebola virus.

The implication of this is that the rural dwellers and forest dependent communities who rely on hunting and marketing of bush meat for sustenance may have to source for other alternative means. Since income is a major index for measuring rural livelihood, the declines in the income of bush meat sellers who depend on this for their livelihood points to it as one of the critical consequences of the disease outbreak.

#### **4.2 Implications on Biodiversity Conservation**

From an ecological viewpoint, we found out that the effect of the Ebola disease outbreak on bush meat enterprise in Nigeria has both direct positive and negative effect on biodiversity conservation. On the positive effect, the overall structural decrease in bush meat selling and consumption associated with the Ebola disease outbreak may have a positive effect on wildlife conservation, although on a short-term basis. Before the outbreak of the Ebola virus, hunting and poaching of wildlife animals as bush meat has remained a major threat to the sustainability of vulnerable wildlife. However, the fear of Ebola disease, which has been attributed to most of these wildlife animals created a temporary reduction in the way these animals are hunted. Hunters are no longer willing to go after game for fear of contracting the disease. Moreover, those who managed to hunt are discouraged from further hunting due to low patronage of bush meat. This is in line with the findings of Chidi [28] who noted that satisfying the high demand for the delicious bushmeat has emptied many pristine forests of its critical wildlife composition. Thus, it can be assumed that the fear created by the incidence of Ebola disease has contributed in preserving this wildlife that was in the danger of extinction.

Therefore, the EVD crisis presented a golden opportunity for fauna resource conservation. Policy makers and other stakeholders in the campaign had a unique opportunity for legislative action in this area. Furthermore, the campaign

against the eating of bush meat should have been sustained - not just to scare people from eating bushmeat but as a precautionary measure against future outbreak. As in Table 2, it was seen that some individuals stopped eating bush meat entirely, indicating that they could have maintained that tempo. They would have started going for alternatives and the business owners would have also gradually changed their business line, likewise the hunters. After all, this was what happened during the outbreak, as individuals had to resort to alternative means of income. However, that opportunity was lost as the government asked people to go back to their normal livelihood to score cheap political points of having eradicated EVD in the country. Thus, individual went back to the killing and consumption of bush meat (Table 3).

This should not in any way be misunderstood as advocating for the use of the fear-factor as a strategy for ensuring wildlife conservation. This is also risky on its own, because the ripple effect may backfire, causing an attempt to eradicate these vectors of the Ebola virus by overzealous health and political actors. This may lead to long-term negative consequences. Ecologically, these vectors have been shown to be of great importance to the maintenance of ecological health and stability [34]. Agriculturally, these vectors are necessary for seed dispersal and most times they consume vermin insects, and in public health, they are good pointers to emerging public health hazards. It is therefore important to apply caution in applying some post-Ebola management policies which most often encourage destruction of these indicator species which could be silent pointers to emerging or reemerging health and environmental risks. Ebola vectors are still ecologically important, and caution should therefore be applied in implementing some blanket destructive policies such as fumigation of caves, indiscriminate culling and poisoned baits in an attempt eliminate supposedly Ebola Disease Virus wildlife reservoirs [35]. There is therefore need to maintain the right balance in managing the outbreak.

Conservation efforts should rather focus on developing methods that are compatible with rural livelihoods and food security [14]. Also, efforts aiming at reducing bush meat consumption in Nigeria may be more effective by focusing on the difference between the consumption patterns of low-income and high-income households, which shows significant

difference. This is because our observation showed that the wealthy class is the ones creating the demand-pull that triggers bush meat hunting. Following this high demand for bush meat from the wealthy class, and the consequent income source it creates for the rural hunters, there is more incentive for bush meat hunting, since a market has been created for it by the wealthy class. Another strategy to reduce the danger on wildlife conservation from bush meat consumption is to engage the services of law enforcement agencies. According Boyles et al. [34], law enforcement is indispensable in mitigating the illegal hunting of wildlife. Such laws should focus on the prohibition of the sale and consumption of endangered wildlife species in urban markets. However, we are of the view that it is unrealistic to enforce complete ban of hunting as many rural households depend on it for survival. It may, therefore, be needed to make a distinction between resilient species which may still be hunted and endangered/vulnerable species.

#### **4.3 Implications for Educational Campaigns**

Our study found that literacy level indeed has significant effect on bushmeat consumption during the Ebola crisis. This means that environmental education should be an indispensable component in conservation strategies, as it has been shown to correlate with bush meat consumption. It is expected that households will more likely consume less bush meat if they are aware of its risky health implications and its potential damage on ecological fauna. However, available evidence seems to suggest that the consumption of bushmeat is more among richer urban dwellers than among poorer rural households [6,36]. This implies that wealthier city-dwellers consume more bush meat than the poorer rural dwellers irrespective of the fear of Ebola disease. Before now, education campaigns on the health risks and ecological consequences of bushmeat hunting have focused on rural areas and around forest-fringed communities [37,38]. However, as it turns out that wealthier city-dwellers may be the more tenacious consumers, there may need to refocus educational campaigns on the dangers of it in order to change the consumption habit of the rich who exert strong demand-pull effect on the enterprise.

This relatively high consumption of bush meat by wealthier urban dwellers may not be

unconnected with their preference for bush meat to other meats, due to the unique taste of bush meat. A study by Mpharm and Bams [15] to determine the drivers of bush meat hunting and its implication for world's mammals found that in addition to the social class currently being associated with the consumption of bush meat, the cultural taste of the meat makes it a top choice amongst other types of meat among the elite class who also aware of the nutritional value of low caloric bushmeat compared to conventional meat. Furthermore, the result of level of education (Table 1) shows that a greater percentage of the consumers lie between the people that spent 10-12 years in school (41.7%) and 12-17 years (26.7). This high educational level as indicated in the study may imply that respondents were well-informed about the nutritional benefit and the social prestige associated with the consumption of bush meat.

As is the case in this study (Table 2), another study conducted to examine people's preference for bushmeat after the Ebola disease outbreak shows that many people have gone back to their old habits of consuming bush meat [9]. This implies that more educational campaigns are needed to sensitize people about the dangers of excessive bush meat consumption. But this time, the campaign should focus more on urban dwellers as they are the ones who create the market for bush meat enterprise.

#### **5. CONCLUSION AND RECOMMENDATIONS**

This study has evaluated the structural effect of the EVD outbreak in West Africa on bush meat enterprise in Nigeria and its implication on biodiversity conservation in the country. It is apparent that the EVDs outbreak caused the bush meat enterprise in the area to nosedive and this resulted in some structural changes, as there was a reduction in both levels of sales and customers' patronage. Notwithstanding, the business regained vitality immediately after the scare. This suggests that the actors in the bush meat enterprise are able to seek alternative means of livelihood and supply of animal protein in the absence of bush meat, as many stopped eating bush meat entirely, and many sellers stopped selling. Also, the hunters stopped killing bush animals. It is therefore noted that this situation provided a unique opportunity for stakeholders in the conservation crusade to catch in and sustain the tempo of zero or reduced bush meat consumption through targeted policy, legislation, advocacy, awareness

creation and public engagement, as was the case during the EVD outbreak in the country. Rather this was not the case.

We therefore posit that information and communication department should be embedded in the Ministries of Agriculture and Health, and that they should be active in dispatching useful and timely information on such outbreaks to sensitize the people on the right preventive and control measures to take. Furthermore, alternative business for the bush meat sellers should be encouraged. This will make them more resilient to withstand shock in the event of a reoccurrence of the Ebola outbreak, and to gradually take them away from the business of hunting to more sustainable livelihood strategies. Also, environmental education on the implications of bush meat consumption should also target the urban dwellers as they have been found to be the major consumers of bush meat. Rural areas educational awareness, through the mass media, should be promoted to sensitize rural dwellers on the dangers and biodiversity implications of bush meat hunting and consumption.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Luisa PB. The overrated effect of cholera and typhoid fever on sanitary reform: The case of linz. *Environment and Society*. 2017;6(1).
2. Richmond JK, Baglolle DJ. Lassa fever: Epidemiology, clinical features and social consequences. *Clinical Review*. 2002; 327(7426).
3. Wittenberg A. Cholera poses grave risks to pregnant women in conflict-affected Nigeria. *United Nations Population Report*; 2017.
4. Akani GC, Dendi D, Licaluis E. Ebola virus effect on bushmeat trade in West Africa. *African Journal of Ecology*. 2014;5(3). DOI: 10.1111/age12231
5. Sarti FM, Adams C, Morsello C, Van Vliet N, Schor T, Yagüe B, Tellez L, Quiceno-Mesa M, Cruz D. Beyond protein intake: Bushmeat as source of micronutrients in the Amazon. *Ecology and Society*. 2015; 20(4):22.
6. Ordaz-Németh I, Arandjelovic M, Boesch L, Gatiso T, Grimes T, Kuehl HS, et al. The socio-economic drivers of bushmeat consumption during the West African Ebola crisis. *PLoS Negl Trop Dis*. 2017; 11(3):e0005450. Available: <https://doi.org/10.1371/journal.pn.0005450>
7. Vega MG, Carpinetti B, Duarte J, Fa JE. Contrasts in livelihoods and protein intake between commercial and subsistence bushmeat hunters in two villages on Bioko Island, Equatorial Guinea. *Conservation Biology*. 2013;27(3):576-587. Available: [http:// dx.doi.org/10.1111/cobi.12067](http://dx.doi.org/10.1111/cobi.12067)
8. Davies G. Bush meat and international development. *Conserv. Biol*. 2002;16(3): 125–132.
9. Dindé AO. Response to the Ebola-related bushmeat consumption ban in rural Côte d'Ivoire. *Agric & Food Secur*. 2017;6(28). DOI: 10.1186/s40066-017-0105-9
10. Adefalu LL, Adekunle AO, Adrioye, Abdulawahab SA, Oladipo FO, Oluwafemi AO. Bushmeat consumption among urban dwellers: A major driver of wildlife hunting in Kwara state, Nigeria. *Journal of Agriculture and Forestry*. 2014;4(1).
11. Bowen-Jones E, Brown D, Robinson E. Assessment of the solution oriented research needed to promote a more sustainable bushmeat trade in Central and West Africa; 2002.
12. Brashares JS, Golden CD, Weinbaum KZ, Barrett CB, Okello GV. Economic and geographic drivers of wildlife consumption in rural Africa. *Proceedings of the National Academy of Sciences*. 2001;108:13931–13936.
13. Fa JE, Brown D. Impacts of hunting on mammals in African Tropical moist forest: Avenue and synthesis. 2009;39(4):231-264. DOI: 10.1111/j.1365.2907.2009.00149.x
14. Nasi R, Brown D, Wilkie D, Bennett E, Tutin C, Van Tol G, Christophersen T. Conservation and use of wildlife-based resources: The bushmeat crisis. *CBD Technical Series no. 33*. Secretariat of the Convention on Biological Diversity and Center for International Forestry Research (CIFOR). 2008;1–50. (Retrieved January 17, 2016)
15. Ripple WJ, et al. Bushmeat hunting and extinction risk to the world's mammals. *R Open Sci*. 2016;3(10):160498
16. Mpharm SR, Bams DM. Transmission of Ebola virus disease: An overview. *Annals of Global Health*. 2014;80(6):444-451.

16. Ajayi O. Bushmeat sellers protest low patronage. Vanguard News; 2014. Available:<http://www.vanguardnews.com>
17. Ndem S, Maurice E, Nbana DD. Effect of Ebola virus disease on bushmeat consumption in Calabar Municipal. Int. J. Business & Law Research. 2015;3(3):32-48.
18. Rohwerder B. Impact and implications of Ebola crisis. Applied Knowledge & Law Services; 2014. Available:[www.gsdr.org](http://www.gsdr.org)
19. Oyediran WO, Omoare AM, Esenwa AO, Omisore OA, Dick TT. Effects of Ebola outbreak on bushmeat marketing and consumption in Ibarapa central local government area of Oyo State, Nigeria. Current Research in Agricultural Sciences. 2015;2(3):90-99.
20. ENADEP. Enugu State Agricultural Development Programme: Annual Report. 2002;27.
21. Sharma G. Pros and cons of different sampling techniques. International Journal of Applied Research. 2017;3(7):749-752.
22. Boynton PM, Greenhalgh T. Selecting, designing, and developing your questionnaire. BMJ; 2014. DOI: 10.1136/bmj.328.7451.1312
23. Koutsoyiannis A. Theory of econometrics. 2<sup>nd</sup> Edition. New York: Palgrave. 1977;82-85,164-166.
24. Frey EF. Tropical deforestation in the Amazon: An economic analysis. Rondonia, Brazil. Issue in Political Economy. Salisbury University. 2002;11.
25. Chow GC. Test of equality between sets of coefficients in two linear regressions. Econometrica. 1960;28(3):591-605. Available:<http://dx.doi.org/10.2307/1910133>
26. Luitel HS, Mahar GJ. A short note on the application of chow test of structural break in US GDP. International Business Research. 2015;8(10):112-116.
27. Bausch DG, Schwarz L. Outbreak of Ebola virus disease in Guinea: Where ecology meets economy. PLoS Negl Trop Dis. 2014;8(7).
28. Chidi N. Ebola: Consumption of bush meat reduces in Imo; 2014. Available:<http://www.vanguardngr.com> (Retrieved on February 2, 2016)
29. Frieden TR, Damon IK. Ebola in West Africa—CDC's role in epidemic detection, control, and prevention. Emerging Infectious Diseases. 2015;21(11):1897–1905.
30. Mutasand S. How Ebola changed the world [online]; 2015. Available:<http://www.bloc.com> (Retrieved 18 January 2016)
31. Agbo-Paul A, Alo A, Ugboja FO, Gbenga A, George O. Business hit, social interactions change as Ebola ravages; 2014. Available:<http://leader.ng> (Retrieved January, 24, 2016)
32. Obiukwu O. How the fear of Ebola is crippling business in West Africa. Business News; 2014.
33. Egbetade AO. Implications of Ebola virus disease on wildlife conservation in Nigeria. The Pan African Medical Journal. 2015; 22(1):16-22.
34. Boyles JG, Cryan PM, McCracken GF, Kunz TH. Economic importance of bats in agriculture. Science. 2011;332(6025):41–42.
35. Adongo PB. Beyond knowledge and awareness: Addressing misconceptions in Ghana's preparation towards an outbreak of Ebola virus disease. PLoS One. 2016;11(2).
36. Levy B, et al. Modeling the role of public health education in Ebola virus disease outbreaks in Sudan. Infectious Disease Modelling. 2017;2(3):323-340.
37. Bonwitt J. Unintended consequences of the 'bushmeat ban' in West Africa during the 2013–2016 Ebola virus disease epidemic. Social Science & Medicine. 2018;200:166-173. Available:<https://doi.org/10.1016/j.socscimed.2017.12.028>

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