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Statistical analysis of the socio-economic impact of ebola outbreak in selected West African countries

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ABSTRACT

Ebola is a severe illness caused by Ebola virus and it is highly contagious, speedily fatal, with a death rate of up to 90%. Ebola can be prevented by avoiding direct contact with body fluids like; saliva, sperm, blood, urine, etc. of an infected person and by contact with pestiferous surfaces - including linen soiled by body fluids from an infected person. The study applied the Ordinary Least Squares (OLS) method. The OLS result showed that in Africa, about 75.04% of the total variation in the number of fatality is jointly explained by the variations in the number of cases, number of deaths and dummy variable (occurrence of Ebola in West Africa). In all, number of cases, number of deaths and number of dummy variable (occurrence of Ebola in West Africa) contributes significantly to the fatality of the Ebola outbreak. The trend of the Ebola outbreak showed that there is massive fluctuation of the fatality of outbreak. The trend also showed that the increase in the number of deaths as a result of the outbreak was noticeable between 2013 and 2014 in West Africa. In the same vein, the number of cases of the outbreak increased sharply between 2013 and 2014 in West Africa. In conclusion, Government should adopt modern security technologies and infrastructures in the health sector by establishing more Ebola healthcare centres which will cater for the manufacturing of vaccines, treatment of affected persons and combat Ebola outbreak challenges, which ranges from cases of reported human virulence, fatality of reported human virulence to death of reported human virulence in the ECOWAS sub-region and Africa as a whole. It will also save cost of importation of vaccines and improve the human capacity building of the African population.

Keywords: Ebola, Ordinary Least Squares (OLS) method

INTRODUCTION

Ebola is a serious disease caused by the virus which is known as Ebola viral hemorrhagic fever. The disease is very fatal and infectious with 90% death rate. It is spread by a contact with the body fluids, like blood, saliva, sperm, etc of the infected person. The first outbreak of Ebola virus on record occurred in 1976 in Zaire (Democratic republic of Congo) and Sudan (Basch *et al*., 2014).

The Ebola virus is now a global crisis, and constitutes one of the most formidable challenges to development and social progress. The outbreak is gradually eroding decades of development gains, and has the potential of seriously undermining our economy with its attendant adverse social and political implications (WHO, 2014).

In Africa, fruit bats of the family pteroposidae are considered natural hosts of filoviruses – the viruses that cause Ebola viruses. Fruit bats belonging to the genus Rousettus are considered potential hosts of the Marburg virus, and bats belonging to the genera Hypsignathus, Epomops, and *Myonycteris* are considered possible hosts of the Ebola virus (WHO 2014).

Infections with Ebola viruses originating from Africa cause a severe disease in humans called Ebola virus disease (EVD). There are five species of the genus *Ebolavirus* (Filorindae family): *Zaire ebola virus,* Reston ebola virus, Taï Forest ebolavirus and Bundibugyo ebolaviru (ECDC, 2014). The current outbreak in West Africa is caused by Zaïre Ebola virus. A concurrent EVD outbreak was declared on 26 August 2014 in the Democratic Republic of Congo. The two outbreaks are not connected (OCHA, 2014).

Ebola viruses are biosafety level-4 pathogens (BSL-4; risk group 4) and require special containment measures and barrier protection, particularly for healthcare workers. The viruses can survive in liquid or dried material for many days (Piercy, 2010). They are inactivated by gamma irradiation, heating for 60 minutes at 60°C or boiling for five minutes, and are sensitive to sodium hypochlorite (bleach) and other disinfectants (PHAC, 2014). Public Health Agency of Canada says freezing or refrigeration will not inactivate Ebola viruses (Chepurnov *et al,* 1995).

The incubation period (the period between infection and first symptoms) is usually four to ten days but can be as short as two days and as long as 21 days. The case-fatality ratio for Zaïre Ebola virus infections is estimated to be between 44% and 90% (Bannister, 2010).

Ebola viruses are highly transmissible by direct contact with infected blood, secretions, tissues, organs and other bodily fluids from dead or living infected persons. Transmission via inanimate objects contaminated with infected bodily fluids (fomites) is possible (Colebunders and Borchert, 2000). The principal mode of transmission in human outbreaks is person-to-person transmission through direct contact with a symptomatic or dead EVD case. Airborne transmission has not been documented. The risk for transmission is considered low in the early phase of human disease (prodromal phase). Burial ceremonies and handling of dead bodies play an important role in transmission (OCHA, 2014).

This outbreak can be eliminated through sodium hypochlorite (bleach)or calcium hypochlorite (bleaching powder), alcohol based product and heat at appropriate concentrations.

There are five types of the disease and they are: Bundibugyo Ebola virus, Taiforest Ebola virus, Zaire Ebola virus and Reston Ebola virus. Among the five types or species, the Zaire type is the most prevalence type or specie, and it constitute a fatality case rate up to 90%. All other species or types except Reston are restricted to Africa, but Reston Ebola virus can be found in the Philippines and appears not to be human pathogen.

This outbreak had done so much constituting a negative impact to the Economy. GDP and investment were predicted to decline over the time, prices of goods were jacked up and many jobs were lost over time. As a result of this, some West Africa countries closed their border (WFP, 2014), while movement were banned and the airlines suspended their flight (WHO, 2014).

In 2014 October, the World Bank estimated between the two year (2014 to 2015) financial impact around $32 billion if the outbreak continues in some West Africa countries (Guinea, Liberia and Sierra Leone). The disease or epidemic has affected export/cash commodities which contributed to the reduction of household income (WFP, 2014). Based on this, the study of this nature identified the impact on the demographic transition in Africa, West Africa and Nigeria.

Given the prevalence of the virus, it is important to carry out empirical research concerning the knowledge of Ebola virus disease (EVD). (Ainsworth and Over, WHO, 2015) reported that Africa account for over 60% of the cumulative cases of EVD worldwide.

Based on this problem, it is necessary to carry out a research on the socio-economic impact of EVD in selected West Africa countries, then provide solutions and recommendations to policy makers.

MATERIALS AND METHODS

Sampling

For the purpose of this study, the sample was purposively selected, owing to the countries involved in the Ebola epidemic

Sampling treatment and analysis

It should be noted that a direct impact of Ebola outbreak on human mortality can be established on the basis of education and health. Thus, this brings the section to the adoption of the conventional "neoclassical" growth theory as modeled by Robert Solow (1956). He holds the view that economic growth as a result of the accumulation of physical capital and expansion of the labour force, in conjunction with an "exogenous" factor technological progress that makes physical capital and labour productive.

It is however imperative that our model can be disaggregated to represent equations below for this research:

$$F_t = \theta_0 + \theta_1 C_t + \theta_2 D_t + \theta_3 DUM + \epsilon_t$$

Where C_t = Cases of Reported Human Virulence

D_t = Deaths of Reported Human Virulence

F_t = Fatality of Reported Human Virulence

DUM = Dummy

E_t = Error time

0 = Other Countries

1 = West African Countries

t = 1976 – 2014

A linear regression will be used to carry out the analysis such that the empirical finding can be deduced from the statistical summary output of the ANOVA tables.

RESULTS AND DISCUSSION

Descriptive Statistics

The descriptive statistics of all the variables used in the study are shown in Table 1. From the Table, the mean value of fatality is 47.62963, case is 185.9259, death is 111.2593, and dummy is 0.777778. The skewness also shows that the entire variables under consideration are not positive.

Jarque-Bera test statistic shows that the series is normally distributed. As the test statistic measures the difference of the skewness and kurtosis of the series.

Table 1. Descriptive statistics of all the variables used in the study

	F_T	C_T	D_T	DUM
Mean	47.62963	185.9259	111.2593	0.777778
Median	53.00000	35.00000	22.00000	1.000000
Maximum	100.0000	2615.000	1427.000	1.000000
Minimum	0.000000	0.000000	0.000000	0.000000
Std. Dev.	33.01416	500.4489	276.2736	0.423659
Skewness	-0.350831	4.461408	4.216077	-1.336306
Kurtosis	1.831612	22.18063	20.56947	2.785714
Jarque-Bera	2.089643	503.4523	427.2610	8.087372
Probability	0.351755	0.000000	0.000000	0.017533
Observation	27	27	27	27

Graphical representation of cases of Ebola outbreak

From Figure 2, it was observed that there was a sharp increase of the number of cases of the Ebola outbreak from 2013 to 2014. This was very visible in the West African region.

Graphical representation of Death of Ebola outbreak

From Figure 3, it was observed that there was a sharp increase in the number of deaths as a result of Ebola outbreak from 2013 to 2014 and this was also very visible in the West African region.

Trend of the outbreak of Ebola

This section covers the trend structure of the fatality, cases and deaths as a result of the Ebola occurrence is given below in charts between 1976 and 2014.

Graphical representation of Fatality of Ebola outbreak

From Figure 1, fatality was more pronounced in the year 2002 in Congo which is not a West African state. There was a sharp decline of the fatality in year 2008. In West Africa, the prevalence took prominence in 2013-2014 with a casualty figure of 55 fatalities. In general, the graph shows fluctuation overtime from 1976 to 2014.

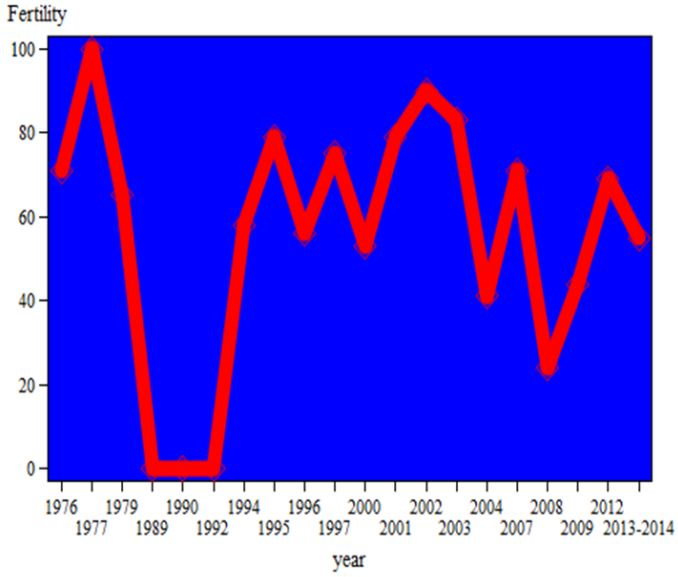

Fig. 1: Trend of Fatality of Ebola Outbreak, 1976-2014

Ordinary Least Squares (OLS) Results

The summary of the result obtained from the ordinary least squares test statistics is presented in Table 2.

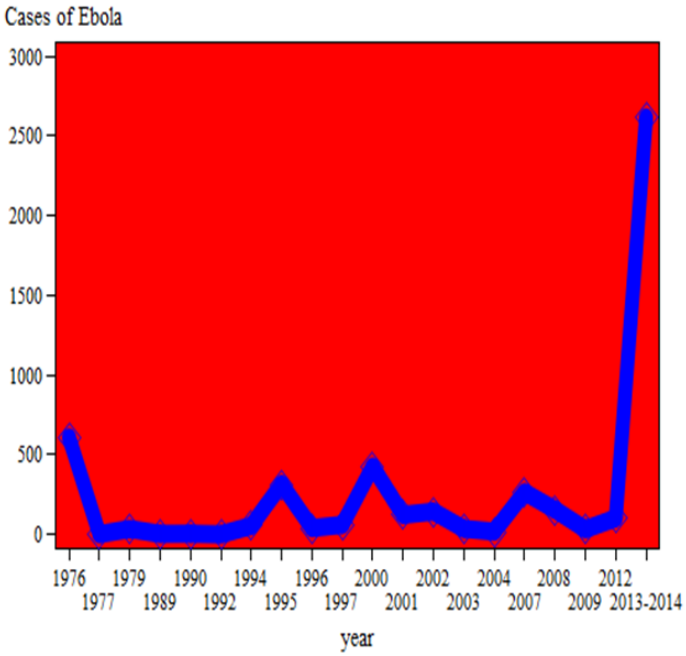

Fig. 2: Trend of Cases of Ebola Outbreak, 1976-2014

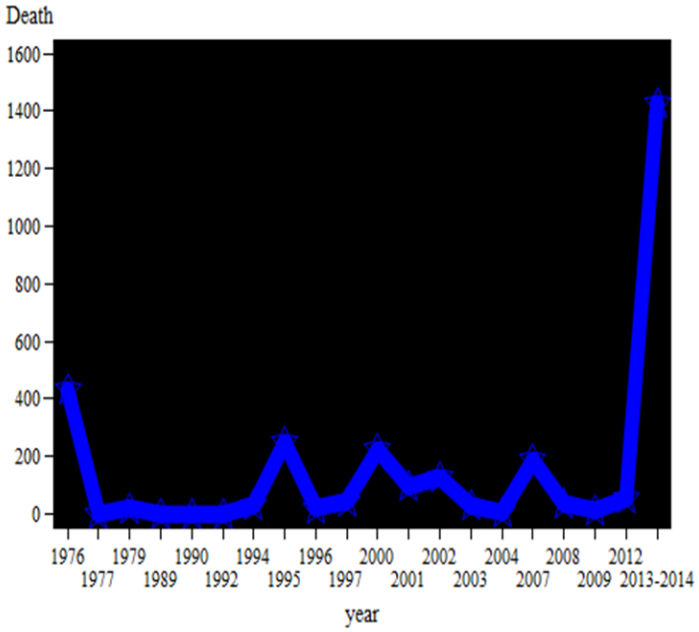

Fig. 3: Trend of Death of Ebola Outbreak, 1976-2014

Table 2. Ordinary least squares test statistics

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.496943	7.160122	0.069404	0.9453
CASES	-0.229358	0.065724	-3.489729	0.0020
DEATH	0.418195	0.119560	3.497777	0.0019
DUMMY	55.60497	8.449953	6.580507	0.0000
R-squared	0.750440	Mean dependent var		47.62963
Adjusted R-squared	0.717889	S.D. dependent var		33.01416
S.E. of regression	17.53518	Akaike info criterion		8.702248
Sum squared resid	7072.095	Schwarz criterion		8.894224
Log likelihood	-113.4804	Hannan-Quinn criter.		8.759333
F-statistic	23.05411	Durbin-Watson stat		1.811612
Prob(F-statistic)	0.000000			

The model obtained is given as:

$$F_t = 0.4969 - 0.2293C_t + 0.4181D_t + 55.6049DUM$$

Looking at the result of the R-square of the model it shows that the variables in the model really represent the model and that the goodness of fit is high as 75.04% and that the independent variables can account for 75.04% of the total variation in the dependent variable and the other percentage that cannot be accounted for are always the error term this shows that the model really fit the equation.

The adjusted R-Squared which is always used to penalize those variables that are not really affecting the model, but in this model it shows that all the variables are important in the model for us to have the Adjusted R-Squared to be 71.78% which is not really different from the R-Squared of the model so with all the variable inculcated in the model the variables are still very able to explain 71.78% of the total variations in the model. It is good fit so the model can be relied upon.

Furthermore, the model specified have F-statistic value of 23.05, this implies that the overall model is statistically significant at 1% and 5% levels of significance, this is because the F statistics

calculated is greater than the F-statistics tabulated and it is significant at 1% and 5% respectively. Hence, all the explanatory variables in the model simultaneously explain the variations in the fatality. In order words, cases, death and dummy combine are statistically significant at 95% confidence interval to determine the fatality of reported human virulence.

Individual Tests of Significance (Student T-Test)

Decision Rule: if $T_{Cal} > T_{Tab}$ - reject H_0 and accept H_1 or when the p-value is less than 5%
$T_{Cal} < T_{Tab}$ - accept H_0 and reject H_1 or when the p-value is greater than 5%
Critical Values: $T_{0.01} = 2.457$, $T_{0.05} = 1.697$ and $T_{0.1} = 1.310$

The T-statistics for Dummy (region in Africa) is greater than all the tabulated value i.e (6.580507) and therefore it can be concluded that it is significant at any significance level also the T-value for death of reported human virulence is greater than all the tabulated values at level of significance at 5%,10% and 1% i.e. (3.4977) this shows that it is significant at any level of statistical significance, therefore we can conclude that the Dummy (region in Africa) and death of reported human virulence are statistically positively significant on the dependent variable so we accept the Null hypothesis. The last variable cases of reported human virulence are greater than all the critical values and it is statistically significant at all the level with a negative coefficient. Therefore, we reject the null hypothesis and conclude that the variable is statistically significant on the dependent variable though with a negative coefficient.

It can be observed that introducing fatality into the model causes the establishment of a relationship between cases of reported human virulence, death of reported human virulence, and Dummy (region in Africa) indicated that one per cent increase of cases of reported human virulence will lead to 0.23 percent decrease in fatality of reported human virulence. This means that the ability for cases to be reported to the hospital leads to the reduction of fatal human virulence, this means that cases of Ebola virus outbreak should be reported if any victim is suspected in the neighbourhood. Also, the result indicated one per cent increase in the death of reported human virulence will lead to 0.42 percent increases in fatality of reported human virulence. This means that death caused by victims infected by their loved ones or during burial as there is a positive relationship between death of reported human virulence and fatality of reported human virulence. Finally, one per cent increase in the trend and structure of Ebola outbreak will lead to 55.60 per cent increase in fatality of reported human virulence.

CONCLUSION AND RECOMMENDATIONS

In conclusion, arising from the result of the findings, the socio-economic implication of the incidence of Ebola virus disease (EVD) are seen in high fiscal deficits and low real household income in some the West African countries. There was a sharp increase in staple goods and food supply was on the decline. Jobs were lost and borders of some countries were closed. Even airlines were suspending flights and free flow of people was bound in an attempt to curb the spread. Even more, cross-border markets were closed, thereby stripping vendors of income. The worse hit sectors are the agriculture, transportation, tourism, mining and manufacturing.

It was estimated by the World Bank in 2014 that an estimated $32 billion was lost in revenue by the governments of Guinea, Liberia and Sierra Leone.

Government should adopt modern security technologies and infrastructures in the health sector by establishing the Ebola healthcare center for the manufacturing of vaccines and treatment of affected persons which we help to combat Ebola outbreak challenges ranging from cases of reported human virulence, fatality of reported human virulence to death of reported human virulence in the ECOWAS sub-region and Africa as a whole. It will also save cost of importation of vaccines and improve the human capacity building of the African population.

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