MERAL IPEK AZIMLI

STATISTICAL ANALYSIS OF THE EBOLA OUTBREAK IN WEST AFRICA

NEU 2017

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A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
MERAL IPEK AZIMLI

In Partial Fulfilling of the Requirements for the Degree of Master of Science in Mathematics

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Meral Ipek AZIMLI: STATISTICAL ANALYSIS OF THE EBOLA OUTBREAK IN WEST AFRICA

Approval of Director of Graduate School of Applied Sciences

Prof. Dr. Nadire ÇAVUŞ

We verify that, this thesis is satisfactory for the award of the degree of Masters of Science in Statistics

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Signature :
Date :

ACKNOWLEDGEMENT

First and foremost, I would to like to thank God, the Almighty, for granting me the opportunity to pursue my masters studies. I also thank him for giving me strength and courage to do this work.

I would like to express my profound gratitude to my supervisor Assoc. Dr. Evren Hincal for being a wonderful advisor. His patience and encouragement were priceless for me. I appreciate all his valuable suggestions which helped me a lot thoughout the study.

I am indeed most grateful to my parents, Emine Azimli and Ekrem Azimli for always believing in me. Their support and constant love always guide me all these years.

I owe a lot of gratitude to my fiance, Esat Obenler for his love, motivation, support and being with me in difficult moments.

I also wish to state my deer appreciations to my whole family and friends for their support and giving me the courage throughout my study.

To my parents and my fiance…

ABSTRACT

In this study, the March 2014 Ebola epidemic, known as the most deadly Ebola epidemic in history, was analyzed using data collected in Guinea, Liberia and Sierra Leone by considering some statistical methods. After drawing a scatter diagram of the number of the cases and the deaths for each country and calculating some ratios; it was easily seen that Sierra Leone is the country with the highest number of the cases and Guinea is the country with the highest fatality rate. Although there is no Ebola epidemic at the moment, using the linear regression equation helped to calculate how many cases and deaths would have reached if this epidemic had continued. Finally, the results of p-values proved that this virus did not show the same effects in the three countries. This shows that there is a need for separate treatment and vaccination for each country.

Keywords : Ebola outbreak; linear regression line; p values; regression model; R squared value; correlation; confidence interval

ÖZET

Bu araştırmada, tarihteki en ölümcül Ebola salgını olarak bilinen Mart 2014'teki salgının bazı istatistik yöntemleri kullanılarak Gine, Liberya ve Sierra Leone ülkelerinde toplanan veriler yardımıyla analizleri yapılmıştır. En fazla vaka sayısının Sierra Leone'da ve ölüm oranının en yüksek olduğu ülke ise Gine olduğu bazı grafikler ve oranlar sonucunda anlaşılmıştır. Şu anda Ebola salgını olmamasına rağmen, doğrusal regresyon denklemi kullanılarak eğer bu salgın devam etmiş olsaydı vaka ve ölüm sayılarının kaça ulaşacağı hesaplandı. Son olarak p değerleri hesaplandı ve bu virüsün 3 ülkede ayni etkileri göstermediği ispatlanmış oldu. Bu da her ülke için ayrı ayrı tedaviye ve aşıya ihtiyaç olduğunu göstermektedir.

Anahtar Sözcükler: Ebola salgını; doğrusal regresyon denklemi; p değeri; regresyon modeli; R karesi değeri; korrelasyon; güven aralığı

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CHAPTER 1
INTRODUCTION

Ebola virus disease is a fatal illness which first appeared in 1976 in Democratic Republic of Congo. It is named after the Ebola River in the Democratic Republic of Congo (formerly known as Zaire). Even though, the host of ebola viruses has not yet been identified, scientists believe that the first person got infected from animals, such as a fruit bat or a primate (apes and monkeys).

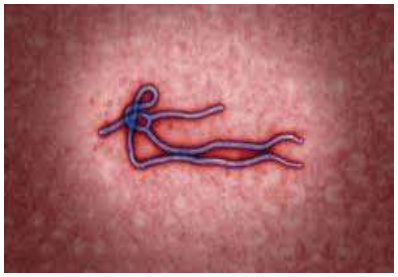

Figure 1.1: Image of Ebola virus. Ebola virus, filamentous structure, is about 80 nm in length. Genetic material consists of RNA

There are five different species of Ebola virus disease; *Bundibugyo ebolavirus, Taï Forest ebolavirus , Sudan ebolavirus, Zaire ebolavirus,* and *Reston ebolavirus*. Only *Reston ebolavirus* has never been verified that it caused the disease in humans but the rest 4 species have. *Zaire ebolavirus* was responsible for more than half of the outbreaks in history. Also, since it has caused the majority of cases and deaths in humans, after a while it was called as *Ebola virus* as a shortcut (Wasburn, 2015).

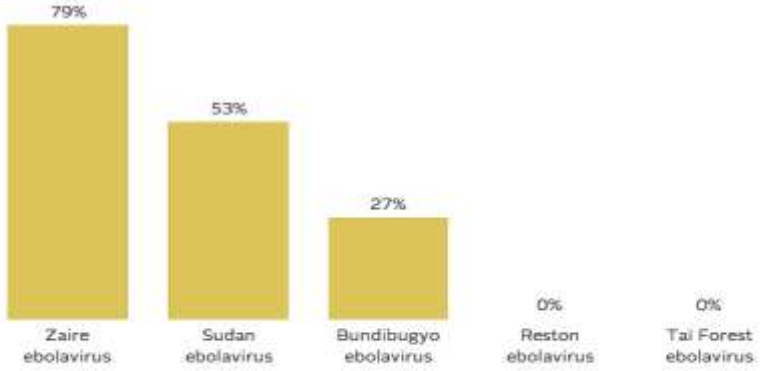

Figure 1.2 : Death rates of the 5 Ebola virus species

There were several Ebola outbreaks in history since it first appeared in 1976. Here is a timeline of Ebola epidemics including number of the cases and deaths.

1976 – The index case of Ebola virus was in Zaire (now Democratic Republic of the Congo). First outbreak of history caused 318 cases and 280 deaths. Also, *sudan ebolavirus* led 284 cases and 151 deaths in South Sudan.

1989 – Macaque monkeys got infected with the *Reston ebolavirus* in Reston, Virginia.

1990 - In Texas and Virginia, four humans who contacted with monkeys with ebola virus developed Ebola antibodies and none of them had symptomes.

1995 – Another outbreak in Democratic Republic of Congo caused 315 reported cases and at least 250 deaths.

2000 – 2001 – In Ugandian outbreak 425 human cases and 224 deaths detected (*Sudan ebolvirus).*

2001 – 2002 – An Ebola virus outbreak occured on the border of Gabon and Republic of the Congo, which ended up with 53 deaths on the Gabon side and at least 43 deaths on the Republic of the Congo side.

December 2002 – April 2003 – An Ebola virus outbreak occured in Democratic Republic of Congo, 128 of the 143 cases reported result in death.

2007 – In the beginning of 2007 Democratic Republic of the Congo outbreak caused 264 cases and 187 deaths. In late 2007, another epidemic broke out in Uganda with 149 cases and 37 deaths.

November 2008 - The *Reston ebolavirus* was detected in five humans in the Philippines. They were the workers on a pig farm and had no symptoms. This was the first time that the ebola virus appeared on a pig.

August 26, 2014 - The Ministry of Health in the Democratic Republic of the Congo informed the World Health Organization about the Ebola outbreak in the country. It was the seventh outbreak in the country since 1976 and ended up with 68 cases and 49 deaths.

But the outbreak was not related with the outbreak in Guinea, Liberia and Sierra Leone (The CNN Wire, 2014).

The main aim of this thesis is to examine the biggest Ebola outbreak in 2014 in Guinea, Liberia and Sierra Leone.

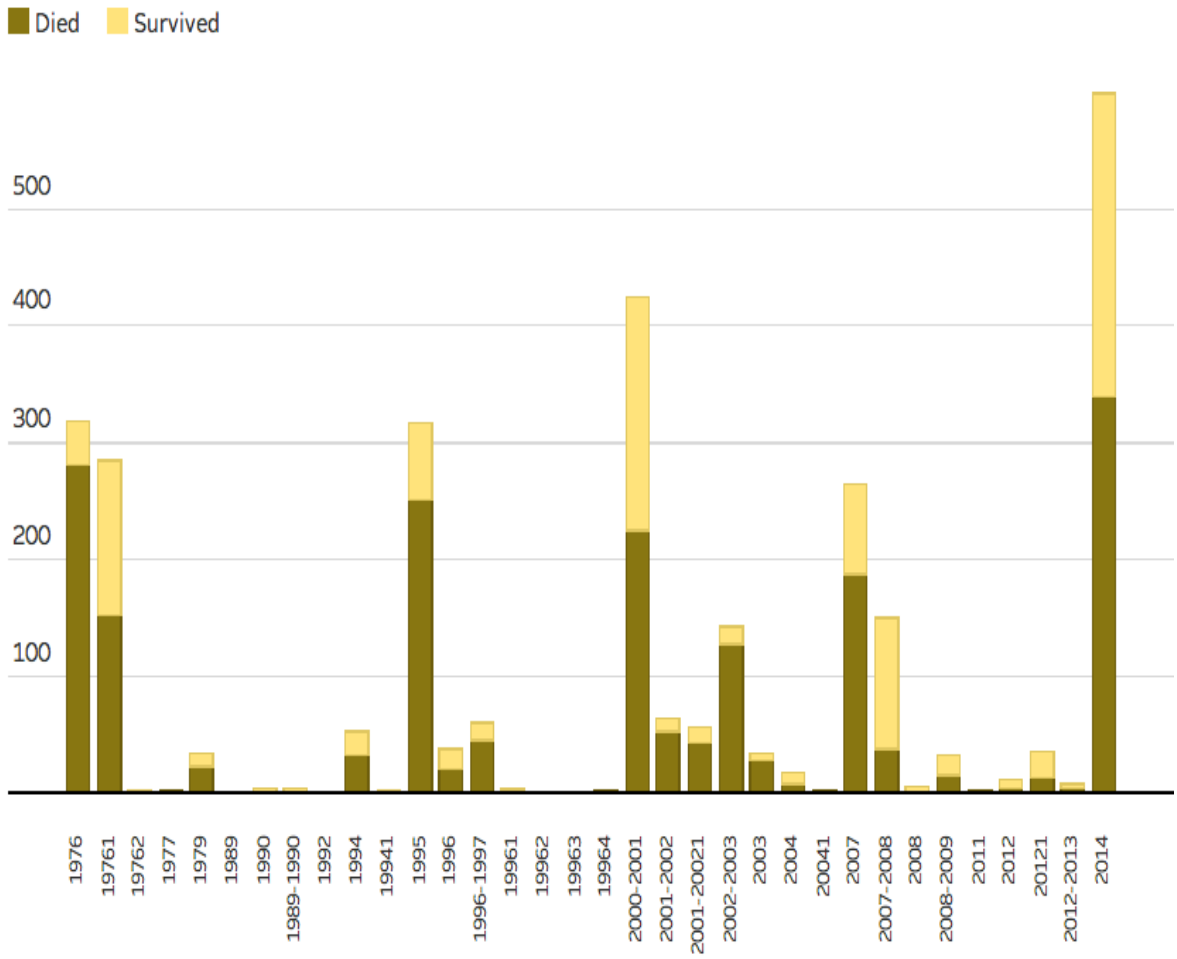

Figure 1.3: Ebola outbreak with the number of the deaths and survivors year by year

Unlike the flu, Ebola virus is not spreadable by air. Transmission of the Ebola virus among the people is mostly caused by a direct contact with blood or body fluids (saliva, sweat, vomit, breast milk, urine and semen) of a person who has the illness or has died from Ebola. In addition; the virus can be infectable by the direct contact with the blood or other bodily fluids of an animal host (such as fruit bats or primates). The main reason why Ebola outbreaks can not keep going years and years is its limited transmission ability.

Since the Ebola virus is very infectious by touching, health workers wear protected uniforms and spray disinfectants on patient's body before carrying an infected person to the hospital. Here is an image of a sick man who was carried by health workers.

(a) First Stage (b) Second Stage

Figure 1.4 : The health workers were carrying a sick man with sterilization procedures

Figure 1.6: A picture of the gloves and the boots used by the medical staff, drying in the sun, at a center for victims of the Ebola virus in Guinea

Initial symptoms of the ebola virus is very similar with fluenza; fever, muscle pain, headache and sore throat. These are then followed by vomitting, diarrhea, rash, symptomes of impaired kidney, worn liver and in some cases internal and external bleeding which often end up with death if untreated.

Figure 1.7: A hemorrhagic rash appears over the entire body

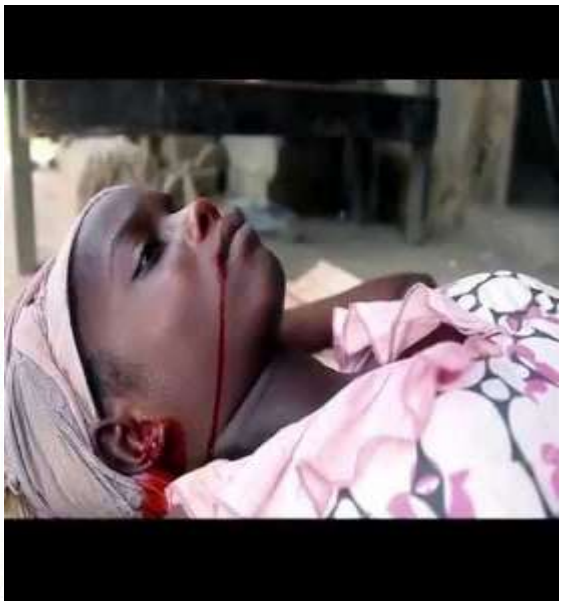

Figure 1.8: Internal and external bleeding occurs

Since 1976, 30 known outbreaks in humans have been reported (Washburn, 2015). In spite of that, the biggest outbreak of the Ebola fever was on March 25, 2014 in Liberia, Guinea and Sierra Leone. It has been reported that 27,443 people had the disease and about 11,207 died (World Health Organization, 2014).

The origin of the biggest ebola outbreak in the history was in Guinea. On December 2013, a two year old boy from Meliandou Village in Gueckedou (the border city between Guinea, Liberia and Sierra Leone where is always very busy since it is allowed to cross on foot and by car amongst the three countries.) had the initial symptomes; fever, vommiting and a diarrhea which were thought that were the symptoms of a cholera or a Lassa fever (viral illness that occurs in West Africa). He was only cared by his mother. After four days of these symptomes, he died. After a short time of his death; his mother, his sister and his grandmother had the same symptomes. His mother was the first who died just after ten days her son death. Two weeks after that, his sister and his grandmother was dead. By the

end of December, the whole family got exactly the same symptomes and passed away. At least two other women got infected after going to the grandmother's funeral. They got infected because the traditional burial practicies include ritual washing, touching and kissing the dead body. Approximately 22 more people died who either went to grandmother's funeral or contacted with people who were at the funeral. By this way, Ebola Virus reached Dandou Pombo Village, in the city of Gueckedou in Guinea. The spread of this dangerous virus continued from Gueckedou to Macenta and from Macenta to Nzerekore which were all in Guinea (Figure 1.9). And so the biggest ebola virus outbreak of 2014 in West Africa began (Rahimi, 2015).

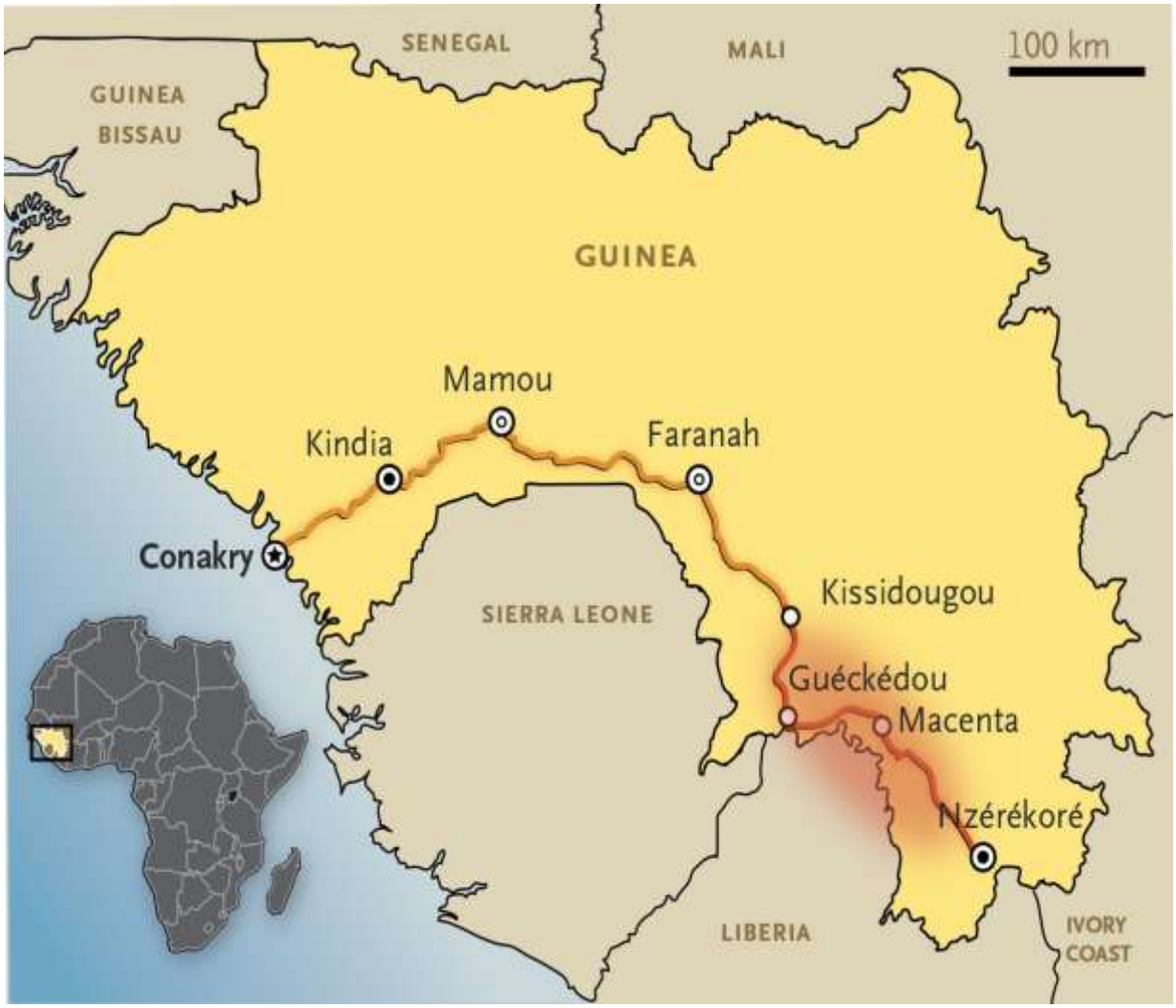

Figure 1.9: The highlighted cities are the main cities which involved in the beginning of the West Afrika's biggest Ebola Outbreak in 2014

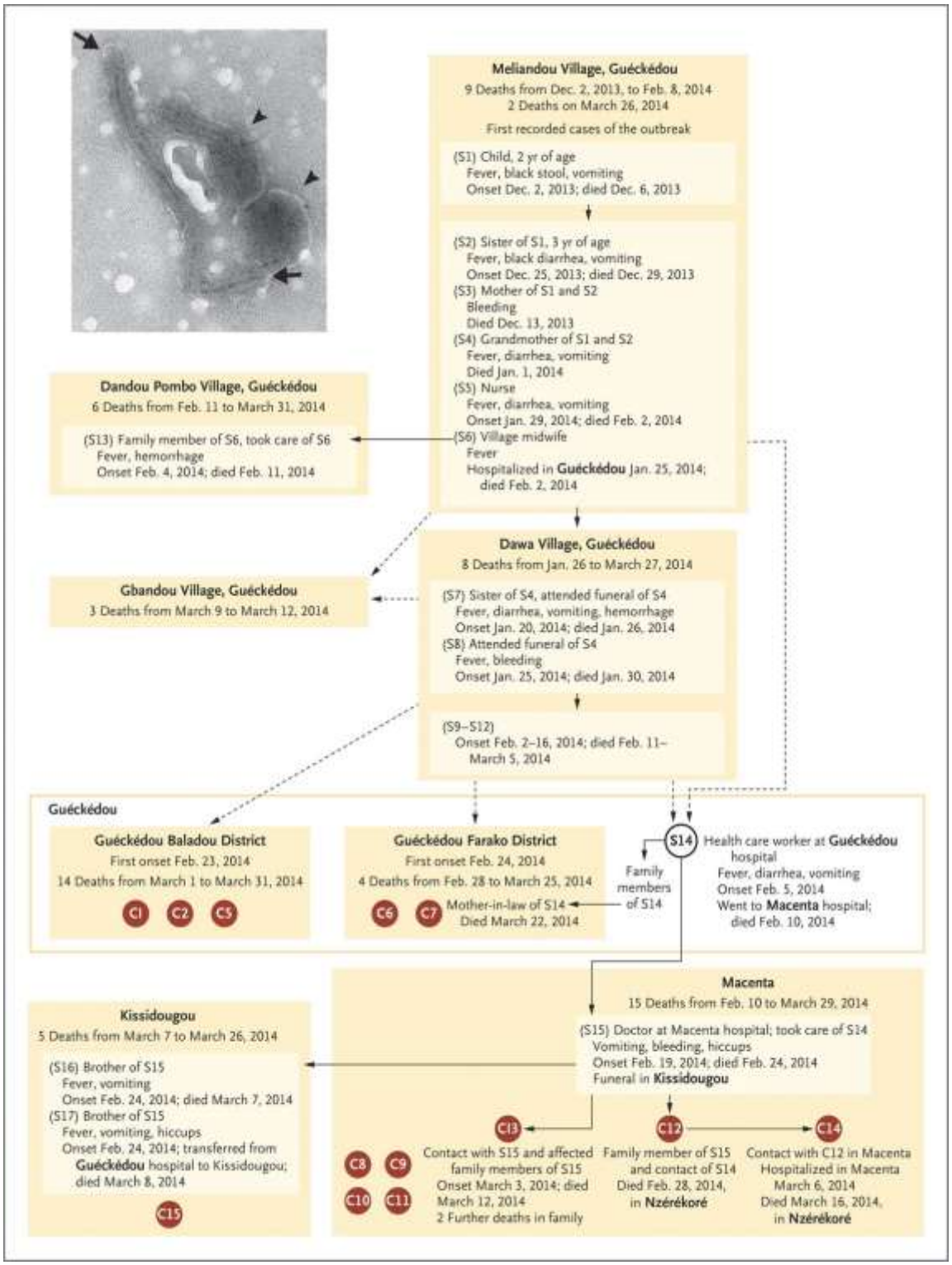

Figure 1.10: This figure shows all the cases from 2 December 2013 to 29 March 2014. The laboratory-confirmed cases are shown in the red circles.

On March 10, 2014, the local public health officials in Gueckedou and Macenta alerted the Ministry of Health in Guinea and Medicins sans Frontieres about Ebola virus oubreak. The World Health Organization in Geneva was officially warned of the outbreak on 23 March 2014.

Unfortunately, since Ebola is a spreading disease, it did not take too much time to reach neighbour countries; Liberia and Sierra Leone. On July 22, 2014, there were 415 cases and 314 deaths in Guinea; 224 cases and 127 deaths in Liberia; 454 cases and 219 deaths in Sierra Leone; for a total of 1093 cases and 660 deaths. These results were taken from Dr. Louis Sambo, the Regional Director of the WHO of the West African Office, who visited the affected regions (Rahimi, 2015). Eight months after the index case, 961 people died and 1779 cases were recorded. On August 8, 2014, the World Health Organization published the outbreak and alarmed the world about this dangerous virus.

After one year of the first outbreak began; the results were terrifying. There were 24,907 suspected and probable cases and 10,326 confirmed deaths (Rahimi, 2015). The 2014 Ebola outbreak was the largest outbreak with maximum mortals which also lasted longer than other outbreaks in the history.

Table 1.1: Mean number of cases and fatalities by country and month which are calculated by using Appendix 1.

	Guinea		**Liberia**		**Sierra Leone**	
Date	**Mean Cases**	**Mean Deaths**	**Mean Cases**	**Mean Deaths**	**Mean Cases**	**Mean Deaths**
March 2014	92	60	0	0	0	0
April 2014	179	114	4	1	1	0
May 2014	248	166	12	11	9	1
June 2014	373	250	38	25	125	37
July 2014	417	347	192	109	403	182
August 2014	514	394	869	469	844	353
September 2014	963	605	2730	1476	1713	562
October 2014	1500	870	4758	2444	3668	1151
November 2014	1950	1174	6941	2899	5843	1256
December 2014	2503	1567	7849	3318	8675	2298
January 2015	2842	1845	8397	3581	10190	3087
February 2015	3070	2021	8990	3877	11019	3371
March 2015	3362	2220	9486	4235	11730	3682

Table 1.1 cont.

April 2015	3553	2353	10109	4518	12244	3866
May 2015	3622	2406	10633	4600	12625	3906
June 2015	3697	2458	10666	4806	12998	3922
July 2015	3729	2484	10667	4807	13126	3932

The March 2014 outbreak was not only in West Africa. It also jumped to Europe and America such as, United States, Spain, United Kingdom, Norway, France and Italy. The first confirmed case of Ebola virus outside the West Africa was in Italy. The patient was a health worker who was working at an Ebola treatment centre in Sierra Leone. Luckily, she was fully recovered from Ebola virus disease.

A Spanish nurse got the Ebola virus when she was trying to treat two other patients. Then, she started to feel ill after a few days, she took the test and the results were positive. She was not the only person in Spain who was sick. A Spanish nurse, her husband and one other were isolated in the hospital because of carrying the Ebola virus disease. After treatment process, two patient got better but unfortunately one of them died.

Other countries with confirmed number of the cases and the deaths are as follows;

- United States: 11 cases and 2 deaths
- Germany: 3 cases and 1 death
- France: 2 cases and 0 death
- United Kingdom: 3 cases and 0 deaths
- Switzerland: 1 case and 0 death
- Netherland: 1 case and 0 death
- Norway: 1 case and 0 death

Ebola virus did not go too long in Europe and USA. There were only 27 cases and 4 deaths in total. This is why we will focus on Ebola virus in Guinea, Liberia and Sierra Leone since it was at peak level in these countries.

The importance of statistics in health is indisputable. Countries use health statistics in order to identify why people die or what causes illness. Statistics can summarize whether the medicine is effective or not for any disease.

The aim of this thesis will be to use some statistical methods in order to analyze the Ebola virus outbreak. We will find the similarities and differences between the Ebola virus in Guinea, Liberia and Sierra Leone by calculating ratios and drawing a scatter diagram with the best fit line. Also, we will make a test and calculate p values to check if the Ebola virus differs from one country to another or not.

CHAPTER 2
MATERIALS AND METHODS

The data used here is completely taken from World Health Organization bulletins and some reports from the health agencies of Guinea, Liberia and Sierra Leone. The data are arranged by (Johnston, 2015).

As there was a huge outbreak of the Ebola virus between March 2014 and July 2015, the number of the cases and the deaths were counted frequently (Appendix 1). Several statistical methods were used in order to compare the similarities and differences of Ebola virus between Guinea, Liberia and Sierra Leone. The data below was analyzed by using Microsoft Excel 2010 and Statistical Package for the SocialSciences for Windows Version 17 (SPSS). The first, the graphs of the number of the cases and the deaths of the three different countries (Guinea, Liberia and Sierra Leone) were drawn in order to find the best fit line or curve for the given sets of data. In the model, the x-axis represents months/years which starts from March 2014 till June 2015. All the data from March 2014 to June 2015 are calculated by using the mean number of cases and deaths by using the Appendix 1. The y-axis represents either the number of the cases or the number of the deaths.

Second of all; the ratios of the deaths to the cases, the cases to 100000 population and the deaths to 100000 population were compared in order to see which country has the highest death rate, whic counry has the highest number of cases and so on.

The Regression analysis, also known as curve fitting, is used to find the ‘‘best fit’’ line or curve between the data points on the scatter diagram. The Regression analysis determines the strength of the relationship between the dependent variable denoted as y (which is the number of the cases or the deaths in Guinea, Liberia and Sierra Leone) and the independent variable denoted as x (which is the time in this thesis). The correlation coefficient , R measures the linear relationship between the two variables. The range of values for the correlation coefficient is -1 to 1. The correlation of -1 indicates a perfect negative correlation, while the correlation of 1 indicates a perfect positive correlation. The value of correlation coefficient was close to 1 in this reseacrch in all situations which shows a very strong positive correlation. The value of R-squared is the percentage of the response

variable variation that is explained by a linear model. It shows how well the regression equation fits the data. R-squared values range from 0 to 1. If R^2 is close to one, then the model's predictions mirror true outcome, tightly. If R^2 is less than 0.5, then either the model does not mirror true outcome, or it only mirrors it loosely. In this case, the linear regression was found to be statisticallt significant with more than 0.9 R-squared value.

2.1 Analyzing Data

2.1.1 Comparing Graphs

In this section, 6 graphs have been drawn about the number of the cases and the deaths in Guinea, Liberia and Sierra Leone. All the graphs were drawn by using data in Appendix 1. The line in each scatter diagram represents the linear regression line about the number of cases and deaths in each country. The y-axis values are from table 1.1, the first data (March 2014) numbered as 1, April 2014 numbered as 2, May 2014 numbered as 3 and so on. Six of these graphs are very similar in a shape.

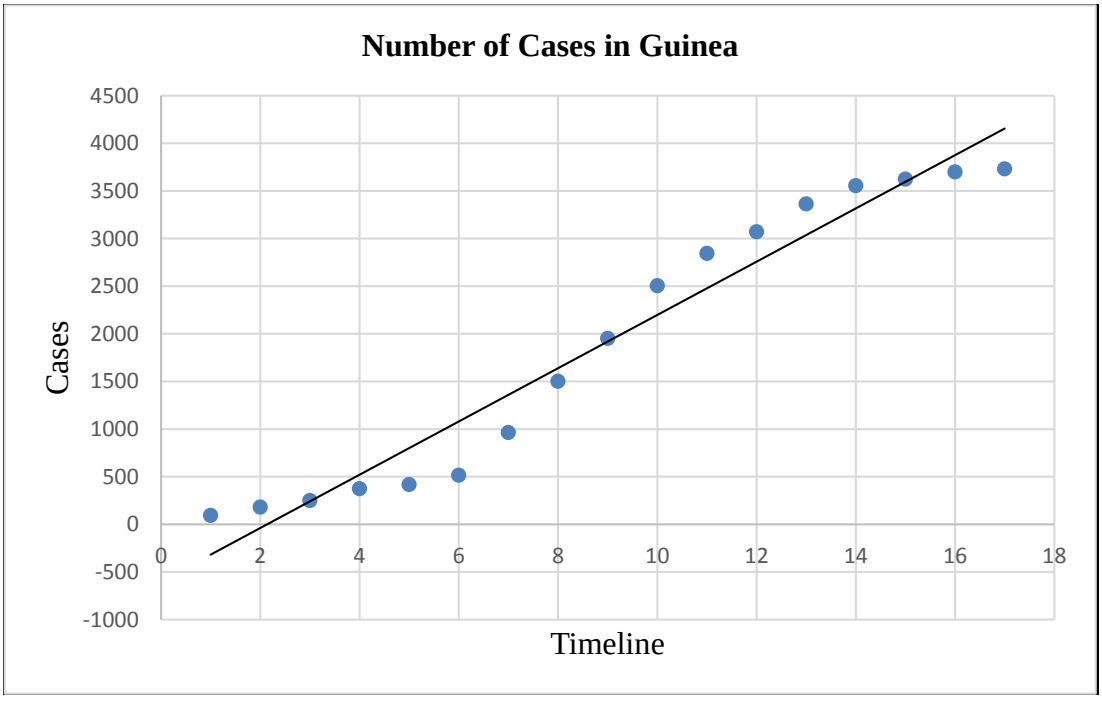

Figure 2.1: The scatter diagram about the number of cases in Guinea. Each point represents the number of cases in the corresponding time

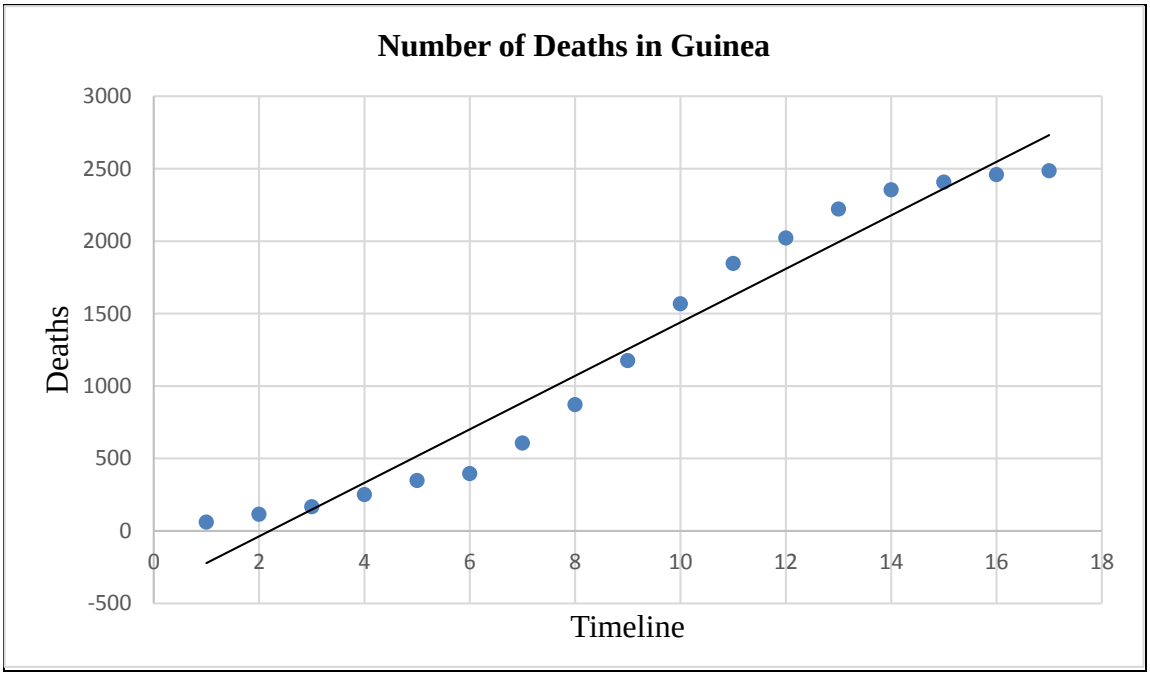

Figure 2.2: The scatter diagram about the number of deaths in Guinea. Each point represents the number of the deaths in the corresponding time

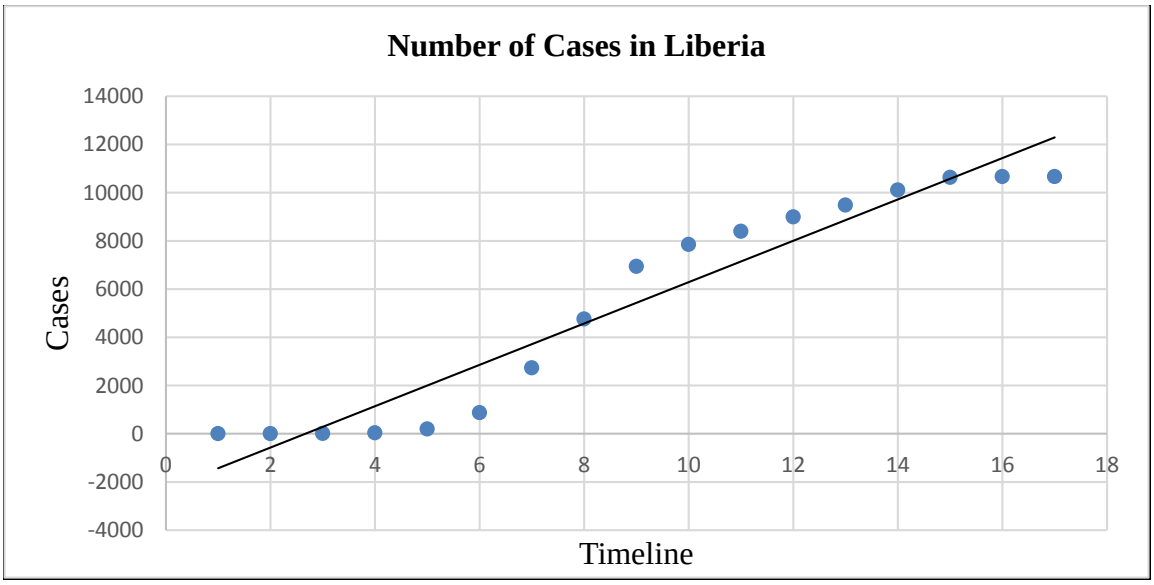

Figure 2.3: The scatter diagram about the number of the cases in Liberia. Each point represents the number of the cases in the corresponding time

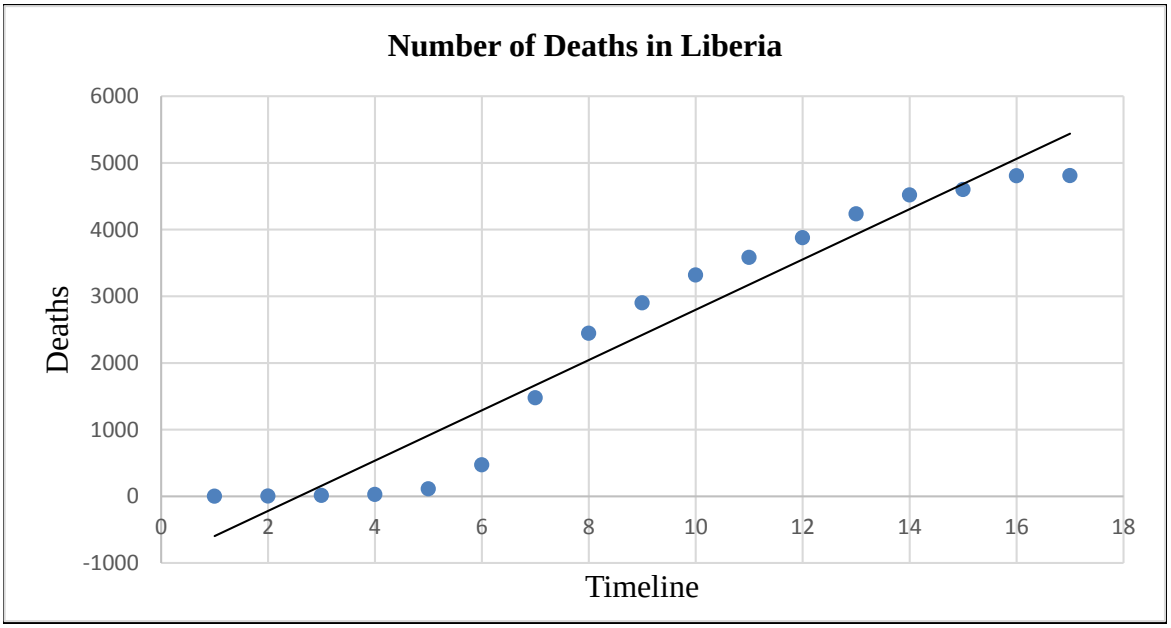

Figure 2.4: The scatter diagram about the number of the deaths in Liberia. Each point represents the number of deaths in the corresponding time

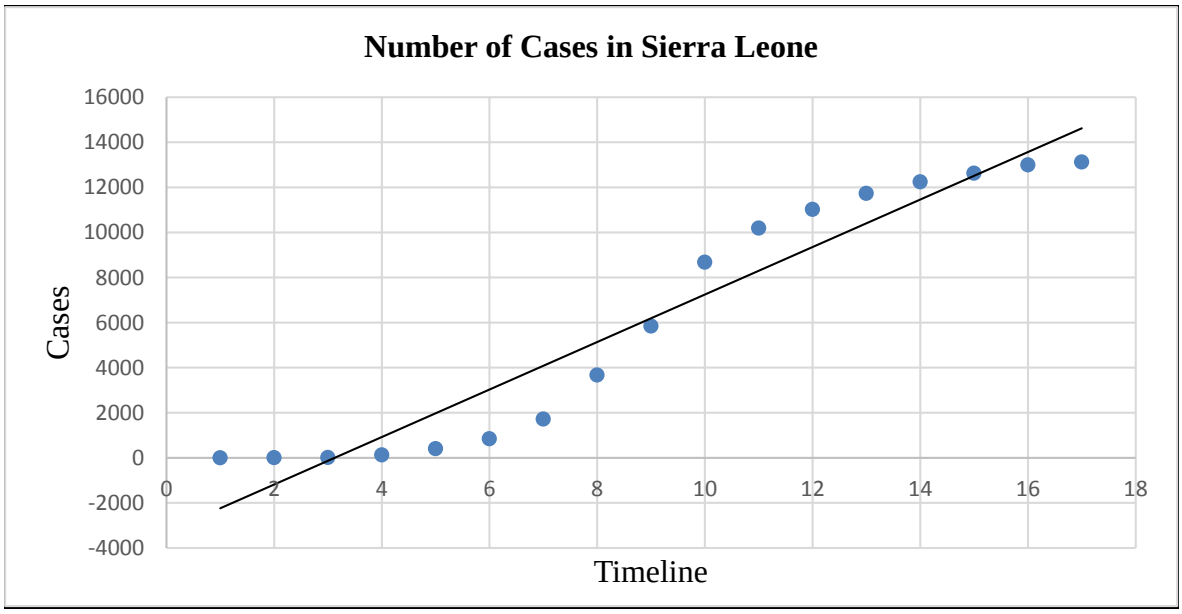

Figure 2.5: The Scatter diagram about the number of thecases in Sierra Leone. Each point represents the number of cases in the corresponding time

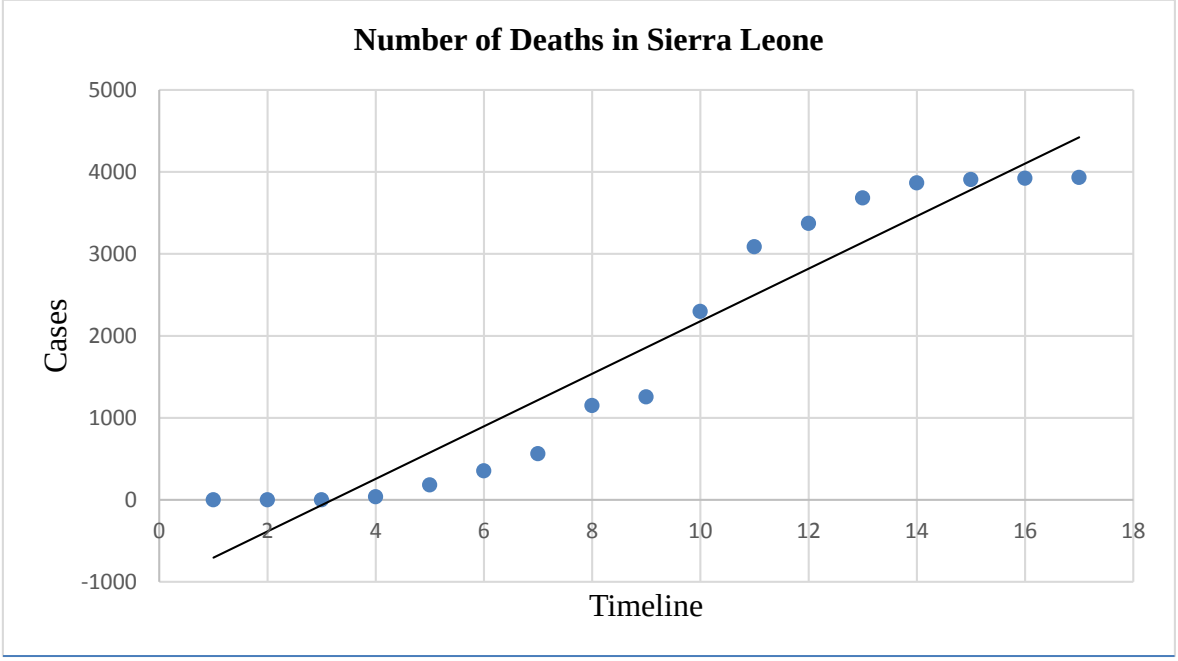

Figure 2.6: Scatter diagram about the number of the deaths in Sierra Leone. Each point represents the number of deaths in the corresponding time

Especially after September 2014, both of the graphs of Guinea started to ascend very quickly. This shows that the number of the cases increased, also followed to that number of the deaths increased. The most risky periods of epidemic for Guinea were from September 2014 to April 2015. After April 2015, the number of cases and deaths become steady in the graphs. Therefore, there were not new cases in Guinea.

Until April 2014, Liberia did not meet with the ebola virus. By June 2014 there were only a few cases. At the end of the Summer 2014, the Ebola virus had become a problem for Liberia too. The number of the cases and the deaths increased visibly from graphs. New registration offices were established and many more cases and deaths were reported by November 2014. Consequently, there is a big jump in Liberia's graphs by this period. As of November 2, Liberia had reported the largest number of the cases (6,525) and the deaths (2,697) among the three affected countries (Guinea, Liberia, and Sierra Leone). Some precautions had to be taken in order to control the disease such as; surveillance, case investigation, laboratory confirmation, contact tracing, safe transportation of persons with suspected Ebola, isolation, infection control within the health care system, community

engagement, and safe burial. Approximately after six months Ebola virus was under control as from the graphs the points became close to a horizontal line.

The graph of Sierra Leone indicates that in the first few months there were no cases. The first case emerged in May 2014. The first victim was a health worker and she suspected and tested for Ebola. The test result was positive. Luckily, the woman made a recovery and no one else in the hospital had suffered from the illness since all the precautions were taken. But; people began to worry about their own lives. There was a famous and respected healer in Kenewa , Sierra Leone. People believed that she uses her healing powers for a recovery of any illness. From other countries, some patients with Ebola fever visited her in order to get rid of the Ebola virus. However, the healer got infected and died. Hundreds of people went to her funeral and burial ceremony in order to honour her memory. Local health authorities claimed that this crowded funeral was reponsible for 365 deaths due to Ebola. The study confirmed the healer's funeral caused the biggest outbreak start in Sierra Leone (World Health Organization, 2017). Depending on that, there is a big rise in the graphs of the cases and the deaths after August 2014. As in the other two countries' graphs, the graphs of Sierra Leone become close to a horizontal line after April 2015 which means the number of cases and deaths stayed the same.

Approximately the same period of time, Guinea, Liberia and Sierra Leone had a very hard time because of the Ebola virus. By the end of June 2015, all three countries were Ebola free.

2.1.2 Comparing Ratios

In this section, 3 different ratios the deaths and the cases, the cases and 100000 population, the deaths and 100000 population) of 3 countries (Guinea, Liberia and Sierra Leone) were compared.

2014 and 2015 populations were used depending on which year the data were from. All the populations are from (Worldometers, 2015).

Table 2.1: Three ratios of the deaths/cases, cases/100000 population, deaths/100000 population for Guinea

GUINEA			
2014 estimation Population:		12,044,000	
2015 estimation Population:		12,608,000	
Month/year	**Deaths/cases**	**Cases/100000 pop**	**Deaths/100000 pop**
March 2014	0,652173913	0,766666667	0,5
April 2014	0,636871508	1,491666667	0,95
May 2014	0,669354839	2,066666667	1,383333333
June 2014	0,670241287	3,108333333	2,083333333
July 2014	0,832134293	3,475	2,891666667
August 2014	0,766536965	4,283333333	3,283333333
September 2014	0,628245067	8,025	5,041666667
October 2014	0,58	12,5	7,25
November 2014	0,589230769	16,25	9,783333333
December 2014	0,626048742	20,85833333	13,05833333
January 2015	0,649190711	22,55555556	14,64285714
February 2015	0,658306189	24,36507937	16,03968254
March 2015	0,660321237	26,68253968	17,61904762
April 2015	0,662257247	28,1984127	18,67460317
May 2015	0,664273882	28,74603175	19,0952381
June 2015	0,664863403	29,34126984	19,50793651
July 2015	0,66613033	29,5952381	19,71428571

Table 2.2: Three ratios of the deaths/cases, the cases/100000 population, thedeaths/100000 population for Liberia

LIBERIA			
2014 estimation Population:		4,396,000	
2015 estimation Population:		4,503,000	
Month/year	**Deaths/Cases**	**Cases/100000 pop**	**Deaths/100000 pop**
March 2014	0	0	0
April 2014	0,25	0,090909091	0,022727273
May 2014	0,916666667	0,272727273	0,25
June 2014	0,657894737	0,863636364	0,568181818
July 2014	0,567708333	4,363636364	2,477272727
August 2014	0,539700806	19,75	10,65909091
September 2014	0,540659341	62,04545455	33,54545455
October 2014	0,513661202	108,1363636	55,54545455
November 2014	0,417663161	157,75	65,88636364

Table 2.2 cont.

December 2014	0,42272901	178,3863636	75,40909091
January 2015	0,426461832	186,6	79,57777778
February 2015	0,431256952	199,7777778	86,15555556
March 2015	0,446447396	210,8	94,11111111
April 2015	0,44692848	224,6444444	100,4
May 2015	0,432615442	236,2888889	102,2222222
June 2015	0,450590662	237,0222222	106,8
July 2015	0,450642167	237,0444444	106,8222222

Table 2.3: Three ratios of the deaths/cases, the cases/100000 population, the deaths/100000 population for Sierra Leone

SIERRA LEONE			
2014 estimation Population:		6,232,000	
2015 estimation Population:		6,319,000	
Month/year	**Deaths/cases**	**Cases/100000 pop**	**Deaths/100000 pop**
March 2014	0	0	0
April 2014	0	0	0
May 2014	0,111111111	0,14516129	0,016129032
June 2014	0,296	2,016129032	0,596774194
July 2014	0,451612903	6,5	2,935483871
August 2014	0,418246445	13,61290323	5,693548387
September 2014	0,328079393	27,62903226	9,064516129
October 2014	0,313794984	59,16129032	18,56451613
November 2014	0,214958069	94,24193548	20,25806452
December 2014	0,264899135	139,9193548	37,06451613
January 2015	0,302944063	161,7460317	49
February 2015	0,305926128	174,9047619	53,50793651
March 2015	0,313895993	186,1904762	58,44444444
April 2015	0,315746488	194,3492063	61,36507937
May 2015	0,309386139	200,3968254	62
June 2015	0,301738729	206,3174603	62,25396825
July 2015	0,299558129	208,3492063	62,41269841

In Guinea, the ratio of the deaths to the cases increased in July 2014 which shows more people died in this month. After July 2014, even though the number of the cases increased, the ratio of deaths to the cases was approximately 0.6 (less than the ratio in July 2014). This was good news, since it was meant that death rate was regular. Also, the last two columns of this table indicate that the number of the cases is directly proportional with the

number of the deaths. Consequently, when there is an increase in cases/population, then there is an increase in the deaths/population.

In Liberia, there is a small jump in the ratios in May 2014 which was the time when Ebola virus was epidemic. The danger bells for Liberia began to ring in September 2014. The cases/population incresed from 19.75 to 62.0455 and the deaths/population increased from 10.659 to 33.545 which was a huge rise in the cases and the deaths. Nevertheless, the deaths/cases did not change too much so the number of the cases and the deaths increased in the same proportion.

Sierra Leone met the Ebola virus in May 2014. In some periods of time such as September, October, November and December 2014 there was a growth in the cases/population and the deaths/population. The number of the cases and the deaths in the population was increased but the deaths/cases stayed approximately the same. Therefore, the country that dealt best with the Ebola Virus looks like a Sierra Leone with the lowest ratio rate between the deaths and cases.

In the last few months, Ebola virus looks under the control in these countries since all the ratios in the tables are very close to a constant within themselves.

2.2 Regression Model Equations

A regression model equation is used to demonstrate the relationship between the two sets of the data. There are many different types of the regression models; linear, logarithmic, polynomial with degree 2 and so on. In this thesis, the linear regression model was used since it gave a very high R-squared which means that the data are closed to the fitted regression line. The higher the R-squared, the better the model fits with the data.

Drawing a 'best fit line' between the points on the scatter diagrams gives you the regression line (Gertman, 2008).The linear regression for the two sets of the data x and y is represented by an equation

$$y = ax + b \tag{2.1}$$

where;

$$b = \frac{S_{xy}}{S_{xx}} \text{ and } a = \bar{y} - b\bar{x} \quad (2.2)$$

Also;

$$\bar{y} = \frac{\sum y}{n} \quad (2.3)$$

$$\bar{x} = \frac{\sum x}{n} \quad (2.4)$$

$$S_{xy} = \sum xy - \frac{\sum x \sum y}{n} \quad (2.5)$$

$$S_{xx} = \sum x^2 - \frac{(\sum x)^2}{n} \quad (2.6)$$

where n is the number of data.

Here is the table showing the regression line equations and R-squared values of the number of the cases and the deaths of 3 countries.

Table 2.4: The regression line equations and R-squared values

	Regression Line Equation	**R-Squared**
Guinea Cases	y=279,6x-597,89	0,9528
Guinea Deaths	y=184,57x-406,2	0,9572
Liberia Cases	y=857,88x-2289,1	0,929
Liberia Deaths	y=377,21x-972,78	0,9419
Sierra Leone Cases	y=1054,1x-3297,9	0,9273
Sierra Leone Deaths	y=320,43x-1024,7	0,9229

The x-value is date and y-value is the number of the expected cases or deaths.

2.3 Expected Cases and Deaths

Undoubtedly, Ebola epidemic was threatening the world. If this outbreak was not prevented, the results would be terrifying. The regression models used to find the expected

cases and the deaths in order to see the future of the world with this dangerous disease if it was not blocked. In this research, the linear model had been used in order to find the expected cases and the deaths for the next years if this outbreak continued. The regression model equations are very useful for future predictions or the indications of the past behaviours.

The linear regression model gave approximately 0.9 value on R-squared which shows that the regression model fits well with the data. Therefore, the linear model was found to be statistically significant. Here are the results of the expected cases and the deaths of Guinea, Liberia and Sierra Leone.

Table 2.5 : The expected cases in Guinea

Number of Cases in Guinea		
Date	**Observed cases**	**Expected cases**
March 2014 (1)	92	0
April 2014 (2)	179	0
May 2014 (3)	248	241
June 2014 (4)	373	521
July 2014 (5)	417	800
August 2014 (6)	514	1080
September 2014 (7)	963	1359
October 2014 (8)	1500	1639
November 2014 (9)	1950	1918
December 2014 (10)	2503	2198
January 2015 (11)	2842	2478
February 2015 (12)	3070	2757
March 2015 (13)	3362	3037
April 2015 (14)	3553	3317
May 2015 (15)	3622	3596
June 2015 (16)	3697	3876
July 2015 (17)	3729	4155
August 2015 (18)	-	4435
September 2015 (19)	-	4714
October 2015 (20)	-	4994
November 2015 (21)	-	5274
December 2015 (22)	-	5553
January 2016 (23)	-	5833
February 2016 (24)	-	6113
March 2016 (25)	-	6392

Table 2.6: The expected deaths in Guinea

Number of Deaths in Guinea		
Date	**Observed deaths**	**Expected deaths**
March 2014 (1)	60	0
April 2014 (2)	114	0
May 2014 (3)	166	148
June 2014 (4)	250	332
July 2014 (5)	347	517
August 2014 (6)	394	701
September 2014 (7)	605	886
October 2014(8)	870	1070
November 2014 (9)	1174	1255
December 2014 (10)	1567	1440
January 2015 (11)	1845	1624
February 2015 (12)	2021	1809
March 2015 (13)	2220	1993
April 2015 (14)	2353	2178
May 2015 (15)	2406	2362
June 2015 (16)	2458	2547
July 2015 (17)	2484	2731
August 2015 (18)	-	2916
September 2015 (19)	-	3101
October 2015 (20)	-	3285
November 2015 (21)	-	3470
December 2015 (22)	-	3654
January 2016 (23)	-	3839
February 2016 (24)	-	4023
March 2016 (25)	-	4208

Table 2.7: The expected cases in Liberia

Number of Cases in Liberia		
Date	**Observed cases**	**Expected cases**
March 2014 (1)	0	0
April 2014 (2)	4	0
May 2014 (3)	12	285
June 2014 (4)	38	1142
July 2014 (5)	192	2000
August 2014 (6)	869	2858
September 2014 (7)	2730	3716
October 2014 (8)	4758	4574

Table 2.7 cont.

November 2014 (9)	6941	5432
December 2014 (10)	7849	6290
January 2015 (11)	8397	7148
February 2015 (12)	8990	8005
March 2015 (13)	9486	8863
April 2015 (14)	10109	9721
May 2015 (15)	10633	10579
June 2015 (16)	10666	11437
July 2015 (17)	10667	12295
August 2015 (18)	-	13153
September 2015 (19)	-	14011
October 2015 (20)	-	14869
November 2015 (21)	-	15726
December 2015 (22)	-	16584
January 2016 (23)	-	17442
February 2016 (24)	-	18300
March 2016 (25)	-	19158

Table 2.8: The expected deaths in Liberia

Number of Deaths in Liberia		
Date	**Observed deaths**	**Expected deaths**
March 2014 (1)	0	0
April 2014 (2)	1	0
May 2014 (3)	11	159
June 2014 (4)	25	536
July 2014 (5)	109	913
August 2014 (6)	469	1290
September 2014 (7)	1476	1668
October 2014 (8)	2444	2045
November 2014 (9)	2899	2422
December 2014 (10)	3318	2799
January 2015 (11)	3581	3176
February 2015 (12)	3877	3554
March 2015 (13)	4235	3931
April 2015 (14)	4518	4308
May 2015 (15)	4600	4685
June 2015 (16)	4806	5063
July 2015 (17)	4807	5440
August 2015 (18)	-	5817
September 2015 (19)	-	6194

Table 2.8 cont.

October 2015 (20)	-	6571
November 2015 (21)	-	6949
December 2015 (22)	-	7326
January 2016 (23)	-	7703
February 2016 (24)	-	8080
March 2016 (25)	-	8457

Table 2.9: The expected cases in Sierra Leone

Number of Cases in Sierra Leone		
Date	**Observed cases**	**Expected cases**
March 2014 (1)	0	0
April 2014 (2)	0	0
May 2014 (3)	9	0
June 2014 (4)	125	919
July 2014 (5)	403	1973
August 2014 (6)	844	3027
September 2014 (7)	1713	4081
October 2014 (8)	3668	5135
November 2014 (9)	5843	6189
December 2014 (10)	8675	7243
January 2015 (11)	10190	8297
February 2015 (12)	11019	9351
March 2015 (13)	11730	10405
April 2015 (14)	12244	11460
May 2015 (15)	12625	12513
June 2015 (16)	12998	13568
July 2015 (17)	13126	14622
August 2015 (18)	-	15676
September 2015 (19)	-	16730
October 2015 (20)	-	17784
November 2015 (21)	-	18838
December 2015 (22)	-	19892
January 2016 (23)	-	20946
February 2016 (24)	-	22001
March 2016 (25)	-	23055

Table 2.10: The expected deaths in Sierra Leone

Number of Deaths in Sierra Leone		
Date	**Observed deaths**	**Expected deaths**
March 2014 (1)	0	0
April 2014 (2)	0	0
May 2014 (3)	1	0
June 2014 (4)	37	257
July 2014 (5)	182	577
August 2014 (6)	353	898
September 2014 (7)	562	1218
October 2014 (8)	1151	1539
November 2014 (9)	1256	1859
December 2014 (10)	2298	2180
January 2015 (11)	3087	2500
February 2015 (12)	3371	2820
March 2015 (13)	3682	3141
April 2015 (14)	3866	3461
May 2015 (15)	3906	3782
June 2015 (16)	3922	4102
July 2015 (17)	3932	4423
August 2015 (18)	-	4743
September 2015 (19)	-	5063
October 2015 (20)	-	5384
November 2015 (21)	-	5704
December 2015 (22)	-	6025
January 2016 (23)	-	6345
February 2016 (24)	-	6666
March 2016 (25)	-	6986

The regression line equations gave negative number of the expected cases of Guinea in March 2014 (1) when it was calculated by using the linear regression equation. Having a negative number of the cases or the deaths doesn't make too much sense, but this shows that the number of the cases or the deaths was going to drop to 0. That is why the first expected cases of Guinea in March 2014 is zero in the table.

The mean number of the cases and the deaths was used as an observed data and the first data (March 2014) numbered as 1. April 2014 numbered as 2, May 2014 (3) and so on. For example, you want to calculate the expected cases in Guinea of June 2019. June 2014 is the 4th data and June 2019 would be $12 \times 5 + 4 = 64$th data (there are 5 years between 2014

and 2019). By using the regression line equation on the table 2.4, $y = 279.6(64) - 597.89 = 17296$, the expected cases are approximately 17296 in June 2019 in Guinea.

CHAPTER 3
RESULTS

In March 2014 epidemic, 11236 out of 27560 individuals died from the Ebola virus disease in Guinea, Liberia and Sierra Leone. The amount corresponding to each country among these number of the cases and the deaths were given as; 2482 dead out of 3729 in Guinea, 4807 dead out of 10669 in Liberia and 3932 dead out of 13126 in Sierra Leone. In Guinea, 0.0296 percent of the population caught the Ebola virus and 0.0197 percent of the population was dead. On the other hand; in Liberia, 0.237 percent of the population was sick and 0.107 percent of the population was killed by the Ebola virus. Finally in Sierra Leone, 0.208 percent of the population became ill, 0.0624 percent of the population died. The case fatality rates of each country were as follows.

- Guinea, 66.6%
- Liberia, 45.1%
- Sierra Leone, 30.0%

Even though Sierra Leone is the smallest country, it had the lowest fatality rate but the Ebola disease looked more dangerous in Guinea with the highest mortality rate. There are differences in the growth rates of the epidemic among countries and also differences in the case reproduction number. The country with the highest number of the cases was Sierra Leone with 13126 confirmed cases. The country that gave the most victim to Ebola virus is Guinea with 4807 deaths. The case incidence decrease the most quickly in Liberia and more slowly in Sierra Leone and Guinea.

The linear regression model used with a very high R- squared value 0.9. The linear regression model was very suitable for the March 2014 epidemic but this epidemic was finished in July 2015. So, the Ebola virus rate will not increase annually as the model is increasing.

The last thing to compare will be p-values. The p-value is used from the two tailed t-tests to regression analysis. P-values are used to indicate the statistical significance in a hypothesis test. The p-value, or the calculated probability, is used in a hypothesis to support or reject the null hypothesis. The p-value is an evidence against a null hypothesis.

The smaller the p-value, the strong the evindence that the null hypothesis must be rejected (Belle, 2004).

Graphically, the p-value is the area under the curve of a probability distribution. In the two tailed test, p-value is the sum of an area under the left and the right end of the tails of the probability distribution. For example;

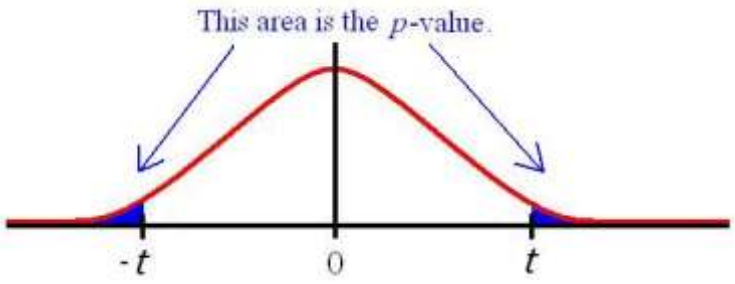

Figure 3.1: The p-value in the two tailed test. The p-value is the sum of the areas which are shaded in blue

The null hypothesis, H_0, is an hypothesis of the 'no difference'. In the thesis, the null hypothesis is there is no difference in the Ebola disease between Guinea, Liberia and Sierra Leone.

The alternative hypothesis, H_1, is the opposite of the null hypothesis and also this is the hypothesis that you try to investigate. The alternative hypothesis is there is a difference in Ebola disease in Guinea, Liberia and Sierra Leone.

The Alpha levels are related with the confidence levels and deteremined by the researchers before the test has been started. Alpha levels have been calculated by subtracting the confidence level by 100%. For example; if you want to have a confidence level to be 97% in your research, then the alpha level will be $100\% - 97\% = 3\%$. When you run the hypothesis test, the test will give you a value for p. Compare that value to your chosen alpha level. For example, in this thesis an alpha level has been chosen as 5% (0.05). Therefore the follwings will identify the results of this thesis (Steward, 2010).

- A small p (≤ 0.05), reject the null hypothesis. This is strong evidence that the null hypothesis is invalid.
- A large p (> 0.05) means the alternate hypothesis is weak, so you do not reject the null (Belle, 2004).

The p-value from the hypothesis test is compared with the alpha level when you are applying the test. The p-value between the cases of three countries, the deaths of 3 countries and the cases and the deaths of 3 countries are done in the table below.

The p-values of this thesis was calculated by using the Statistical Package for the Social Sciences for the Windows Version 17 (SPSS).

Table 3.1: The p-values between the number of the cases of 3 countries

Pairs	p-value
Guinea cases & Liberia cases	<0.05
Guinea cases & Sierra Leone cases	<0.05
Liberia cases & Sierra Leone cases	<0.05

Table 3.2: The p-values between number of the deaths of 3 countries

Pairs	p-value
Guinea deaths & Liberia deaths	<0.05
Guinea deaths & Sierra Leone deaths	<0.05
Liberia deaths & Sierra Leone deaths	<0.05

Table 3.3: The values between number of cases and deaths of each country

Pairs	p-value
Guinea cases & Guinea deaths	<0.05
Liberia cases & Liberia deaths	<0.05
Sierra Leone cases & Sierra Leone deaths	<0.05

In the beginning of this research, the Ebola virus looked the same in all countries, all the smptomes looked the same, all the transmition styles did not look different and so many other similarities. But the result was very interesting. All p-values were less than 0.05. Very small value of p indicates that the null hypoyhesis is goint to be rejected. As a result, the null hypothesis was invalid so the Ebola virus differed from one country to another. This means that if a new treatment was discovered for Guinea, then this treatment would not be effective in Liberia and Sierra Leone.

Before the epidemic recurs, some precautions has to be taken in order to control Ebola virus disease; surveillance, detection and diagnosis quickly, isolation of the patient rapidly, supportive clinical care, control the disease and prevent its spread, safe burial ceremonies and engagement of the community. Throughout the history, West African epidemics have shown that, it is preventable; immediate detection and treatment of the patient will control the transmission. Most importantly, especially health services and community should always be ready for the next Ebola epidemic.

After April 2015 in Guinea, the use of the vaccination most probably reduced the rate of the transmission. Also classic Ebola control methods such as determine the cases with symptomes, isolation cases, treatment should be at Ebola cure center and also safe burial ceremonies helped to block the transmission.

CHAPTER 4
CONCLUSION

In this thesis, the deadliest Ebola outbreak in the history had been invested in Guinea, Liberia and Sierra Leone by using the different statistical methods. By using the ratio deaths/cases, we found the country with the highest mortality rate, also the country which has the most number of cases when we compare it to its population. The graphs helped us to see which period of the time Ebola virus had its peak. The linear regression model is used to have an idea about the future world with the Ebola virus if it was not stopped.

Finally, we checked the p-values. The analysis showed that the Ebola is unstable amongst these countries. So, for the each country, the different treatment options and the different vaccinacions will have to be found. Therefore; the doctors should treat the patients by considering the country they are infected from when treating them.
The Ebola virus may not be very threatening right now but this may change in a negative way in the future.

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APPENDICES

Appendix 1

Ebola Cases And Fatality By Country And Date, Monthly

Cases below included both confirmed and unconfirmed cases. Data are from World Health Organization bulletins. (entries with no bulletin date given).

Bulletin Date	Data Date	Total		Guinea		Liberia		Sierra Leone	
		cases	deaths	cases	deaths	cases	deaths	cases	deaths
23 Mar 2014	22 Mar 2014	49	29	49	29				
24 Mar 2014	24 Mar 2014	86	59	86	59				
25 Mar 2014	25 Mar 2014	86	60	86	60				
26 Mar 2014	26 Mar 2014	86	62	86	62				
27 Mar 2014	27 Mar 2014	103	66	103	66				
30 Mar 2014	28 Mar 2014	112	70	112	70				
1 Apr 2014	31 Mar 2014	122	80	122	80				
2 Apr 2014	1 Apr 2014	127	83	127	83				
5 Apr 2014	4 Apr 2014	143	86	143	86				
7 Apr 2014	7 Apr 2014	151	95	151	95				
10 Apr 2014	9 Apr 2014	163	101	158	101	5			
14 Apr 2014	14 Apr 2014	174	108	168	108	6			
17 Apr 2014	16 Apr 2014	203	122	197	122	6			
19 Apr 2014	17 Apr 2014	209	129	203	129	6			
22 Apr 2014	20 Apr 2014	219	142	208	136	8	6	3	
25 Apr 2014	23 Apr 2014	229	147	218	141	8	6	3	
28 Apr 2014	26 Apr 2014	235	149	224	143	8	6	3	
2 May 2014	1 May 2014	242	160	226	149	13	11	3	
6 May 2014	3 May 2014	247	166	231	155	13	11	3	
8 May 2014	5 May 2014	251	168	235	157	13	11	3	

Bulletin Date	Data Date	Total		Guinea		Liberia		Sierra Leone	
		cases	deaths	cases	deaths	cases	deaths	cases	deaths
9 May 2014	7 May 2014	252	169	236	158	13	11	3	
12 May 2014	10 May 2014	248	168	233	157	12	11	3	
15 May 2014	12 May 2014	263	182	248	171	12	11	3	
24 May 2014	23 May 2014	273	185	258	174	12	11	3	
28 May 2014	27 May 2014	309	202	281	186	12	11	16	5
30 May 2014	28 May 2014	353	210	291	193	12	11	50	6
4 Jun 2014	1 Jun 2014	419	225	328	208	12	11	79	6
6 Jun 2014	3 Jun 2014	437	232	344	215	12	11	81	6
10 Jun 2014	5 Jun 2014	452	244	351	226	12	11	89	7
18 Jun 2014	17 Jun 2014	528	337	398	264	33	24	97	49
22 Jun 2014	18 Jun 2014	567	350	390	267	41	25	136	58
24 Jun 2014	22 Jun 2014	599	338	390	270	51	34	158	34
1 Jul 2014	30 Jun 2014	759	467	413	303	107	65	239	99
3 Jul 2014	2 Jul 2014	779	481	412	305	115	75	252	101
8 Jul 2014	6 Jul 2014	844	518	408	307	131	84	305	127
10 Jul 2014	8 Jul 2014	888	539	409	309	142	88	337	142
15 Jul 2014	12 Jul 2014	964	603	406	304	172	105	386	194
17 Jul 2014	14 Jul 2014	982	613	411	310	174	106	397	197
19 Jul 2014	17 Jul 2014	1,048	632	410	310	196	116	442	206
24 Jul 2014	20 Jul 2014	1,093	660	415	314	224	127	454	219
27 Jul 2014	23 Jul 2014	1,201	672	427	319	249	129	525	224
31 Jul 2014	27 Jul 2014	1,323	729	460	339	329	156	533	233
4 Aug 2014	1 Aug 2014	1,603	887	485	358	468	255	646	273
6 Aug 2014	4 Aug 2014	1,711	932	495	363	516	282	691	286

Bulletin Date	Data Date	Total		Guinea		Liberia		Sierra Leone	
		cases	deaths	cases	deaths	cases	deaths	cases	deaths
8 Aug 2014	6 Aug 2014	1,779	961	495	367	554	294	717	298
11 Aug 2014	9 Aug 2014	1,848	1,013	506	373	599	323	730	315
13 Aug 2014	11 Aug 2014	1,975	1,069	510	377	670	355	783	334
15 Aug 2014	13 Aug 2014	2,127	1,145	519	380	786	413	810	348
19 Aug 2014	16 Aug 2014	2,252	1,244	543	394	846	481	848	365
20 Aug 2014	18 Aug 2014	2,473	1,350	579	396	972	576	907	374
22 Aug 2014	20 Aug 2014	2,615	1,427	607	406	1,082	624	910	392
29 Aug 2014	26 Aug 2014	3,071	1,553	648	430	1,378	694	1,026	422
4 Sep 2014	31 Aug 2014	3,707	1,848	771	494	1,698	871	1,216	476
5 Sep 2014	5 Sep 2014	3,967	2,105	812	517	1,871	1,089	1,261	491
8 Sep 2014	6 Sep 2014	4,291	2,296	862	555	2,046	1,224	1,361	509
12 Sep 2014	7 Sep 2014	4,388	2,226	861	557	2,081	1,137	1,424	524
16 Sep 2014	13 Sep 2014	4,985	2,461	936	595	2,407	1,296	1,620	562
18 Sep 2014	14 Sep 2014	5,347	2,630	942	601	2,710	1,459	1,673	562
22 Sep 2014	20 Sep 2014	5,864	2,811	1,008	632	3,022	1,578	1,813	593
24 Sep 2014	21 Sep 2014	6,263	2,917	1,022	635	3,280	1,677	1,940	597
26 Sep 2014	23 Sep 2014	6,574	3,091	1,074	648	3,458	1,830	2,021	605
1 Oct 2014	28 Sep 2014	7,178	3,338	1,157	710	3,696	1,998	2,304	622
3 Oct 2014	1 Oct 2014	7,492	3,439	1,199	739	3,834	2,069	2,437	623
8 Oct 2014	5 Oct 2014	8,033	3,865	1,298	768	3,924	2,210	2,789	879
10 Oct 2014	8 Oct 2014	8,399	4,033	1,350	778	4,076	2,316	2,950	930
15 Oct 2014	11 Oct 2014	8,997	4,493	1,472	843	4,249	2,458	3,252	1,183
17 Oct 2014	14 Oct 2014	9,216	4,555	1,519	862	4,262	2,484	3,410	1,200
22 Oct 2014	19 Oct 2014	9,936	4,877	1,540	904	4,665	2,705	3,706	1,259

Bulletin Date	Data Date	Total		Guinea		Liberia		Sierra Leone	
		cases	deaths	cases	deaths	cases	deaths	cases	deaths
25 Oct 2014	23 Oct 2014	10,220	4,953	1,553	926	4,744	2,737	3,896	1,281
29 Oct 2014	27 Oct 2014	13,703	4,920	1,906	997	6,535	2,413	5,235	1,500
31 Oct 2014	29 Oct 2014	13,567	5,147	1,667	1,018	6,535	2,609	5,338	1,510
5 Nov 2014	2 Nov 2014	13,042	4,818	1,731	1,041	6,525	2,697	4,759	1,070
7 Nov 2014	4 Nov 2014	13,268	4,960	1,760	1,054	6,619	2,766	4,862	1,130
12 Nov 2014	9 Nov 2014	14,098	5,160	1,878	1,142	6,822	2,836	5,368	1,169
14 Nov 2014	11 Nov 2014	14,413	5,177	1,919	1,166	6,878	2,812	5,586	1,187
19 Nov 2014	16 Nov 2014	15,145	5,420	1,971	1,192	7,069	2,964	6,073	1,250
21 Nov 2014	18 Nov 2014	15,351	5,459	2,047	1,214	7,082	2,963	6,190	1,267
26 Nov 2014	23 Nov 2014	15,935	5,689	2,134	1,260	7,168	3,016	6,599	1,398
3 Dec 2014	30 Nov 2014	16,875	6,070	2,164	1,327	7,365	3,145	7,312	1,583
10 Dec 2014	7 Dec 2014	17,942	6,388	2,292	1,428	7,719	3,177	7,897	1,768
17 Dec 2014	14 Dec 2014	18,603	6,915	2,416	1,525	7,797	3,290	8,356	2,085
24 Dec 2014	21 Dec 2014	19,497	7,588	2,597	1,607	7,862	3,384	9,004	2,582
31 Dec 2014	28 Dec 2014	20,206	7,904	2,707	1,708	8,018	3,423	9,446	2,758
7 Jan 2015	4 Jan 2015	20,747	8,235	2,775	1,781	8,157	3,496	9,780	2,943
14 Jan 2015	11 Jan 2015	21,296	8,429	2,806	1,814	8,331	3,538	10,124	3,062
21 Jan 2015	18 Jan 2015	21,724	8,641	2,871	1,876	8,478	3,605	10,340	3,145
28 Jan 2015	25 Jan 2015	22,092	8,810	2,917	1,910	8,622	3,686	10,518	3,199
4 Feb 2015	1 Feb 2015	22,495	8,981	2,975	1,944	8,745	3,746	10,740	3,276
11 Feb 2015	8 Feb 2015	22,894	9,177	3,044	1,995	8,881	3,826	10,934	3,341
18 Feb 2015	15 Feb 2015	23,253	9,380	3,108	2,057	9,007	3,900	11,103	3,408
25 Feb 2015	22 Feb 2015	23,729	9,604	3,155	2,091	9,238	4,037	11,301	3,461
4 Mar 2015	1 Mar 2015	23,969	9,807	3,219	2,129	9,249	4,117	11,466	3,546

Bulletin Date	Data Date	Total		Guinea		Liberia		Sierra Leone	
		cases	deaths	cases	deaths	cases	deaths	cases	deaths
11 Mar 2015	8 Mar 2015	24,282	9,976	3,285	2,170	9,343	4,162	11,619	3,629
18 Mar 2015	15 Mar 2015	24,701	10,194	3,389	2,224	9,526	4,264	11,751	3,691
25 Mar 2015	22 Mar 2015	24,907	10,326	3,429	2,263	9,602	4,301	11,841	3,747
1 Apr 2015	29 Mar 2015	25,213	10,460	3,492	2,314	9,712	4,332	11,974	3,799
8 Apr 2015	5 Apr 2015	25,550	10,587	3,515	2,333	9,862	4,408	12,138	3,831
15 Apr 2015	12 Apr 2015	25,826	10,704	3,548	2,346	10,042	4,486	12,201	3,857
22 Apr 2015	19 Apr 2015	26,079	10,823	3,565	2,358	10,212	4,573	12,267	3,877
29 Apr 2015	26 Apr 2015	26,312	10,899	3,584	2,377	10,322	4,608	12,371	3,899
6 May 2015	3 May 2015	26,628	11,020	3,589	2,386	10,564	4,716	12,440	3,903
13 May 2015	10 May 2015	26,759	11,080	3,597	2,392	10,604	4,769	12,523	3,904
20 May 2015	17 May 2015	26,969	11,135	3,635	2,407	10,666	4,806	12,632	3,907
27 May 2015	24 May 2015	27,049	11,149	3,641	2,420	10,666	4,806	12,706	3,908
3 Jun 2015	31 May 2015	27,181	11,162	3,652	2,429	10,666	4,806	12,827	3,912
	8 Jun 2015	27,221	11,168	3,669	2,435	10,666	4,806	12,850	3,912
17 Jun 2015	14 Jun 2015	27,341	11,184	3,674	2,444	10,666	4,806	12,965	3,919
24 Jun 2015	21 Jun 2015	27,479	11,222	3,718	2,473	10,666	4,806	13,059	3,928
1 Jul 2015	28 Jun 2015	27,550	11,235	3,729	2,482	10,666	4,806	13,119	3,932
	3 Jul 2015	27,650	11,236	3,729	2,482	10,667	4,807	13,126	3,932