Mortality Differentials in Gender, Income Level and Cause of Death

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Abstract: The reduction in mortality within a nation is a major objective of the government and international organizations. To achieve this goal, indicators of high mortality among disadvantaged people, communities and regions need to be examined and the relationship between these mortality differentials need to be carried out in order to accurately identify how inequalities operate at different levels. The objective of this research is to analyse the mortality differentials in gender, causes of deaths and income levels in order to identify high risk cases where health programmes can be channeled or intensified. In the course of this study, visits were made to hospitals, friends and family members for personal observations, investigation and data collection in order to have comprehensive knowledge on the subject matter. The data were obtained from publications, surveys of health or health related organizations. Male mortality and female life expectancy are higher at all ages in most countries across the globe. In Nigeria, most deaths (in rank) arise from lower respiratory infections, neonatal disorders, HIV/AIDS and malaria, while the leading causes of deaths (in rank) in Africa as a whole are lower respiratory tract infections, HIV/AIDS, diarrhea diseases and ischemic heart diseases. In the world (as a whole), ischemic heart diseases and stroke are leading causes of deaths. Most deaths in lower income group are due to causes that may be treatable through access to basic health services, while most deaths in higher income group are associated with environmental factors and/or natural disasters. In order to minimize the differences in health outcomes and maximize the health gains, responses that are aimed at mitigating exposure to risk factors and/or adequate access to health services should be employed.

Keywords: Gender, income levels, mortality, causes of death, differentials.

1. INTRODUCTION

1.1 Background to the Study

According to Son (2001), education has an influence on occupation which in turn influences material living conditions and health inequalities, therefore, education and occupation are stronger determinants of health. Under normal circumstances, people with higher levels of education have chances of higher potential wages and hence higher income levels, and are thus able to purchase more health enhancing goods and services such as physician or hospital services, healthier feeding, larger living space and more leisure. They are also more able to afford to live in less polluted areas with better public and private health services as poor or polluted environments tend to expose people to disease causing agents, predisposing them to high mortality. The difference between the rich and the poor is better explained by the concept of the Deprivation Model. It is believed that the rich live longer than the poor people who suffer ill health and premature deaths because of poverty and low status which exact a health toll on them not only through absolute deprivation of material resources but also through interpersonal stress and impaired relationship. Mortality differentials can occur as a result of gender. Examples of gender related factors resulting in differentials are: early pregnancy or child marriage which increases girls' risk of adverse health outcomes; gender based division of labour where men and women may be exposed to different injuries for work related injuries/illness; gender norms related to masculinity which promote smoking and alcohol use among men; and women access to health services may be limited by control of household financial resources and restrictions on their mobility. Significant mortality differentials are associated with marital status as mortality is lower among married people and higher among single people, and the potential pathways suggested for this association includes a protective effect of the lifestyle of married people and a selection effect of being married (Manor, Eisenbach, Peritz,& Friedlander, 1999). Differences in mortality are well pronounced in active ages (below 60 years) compared to old age range (above 60 years old) of the population where the eventual

probability of death for each old person will be moving close to 100%. According to World Population Review (2019), there are multiple ethnic groups in Nigeria where the North outnumbers the rest, accounting for about two-thirds of the population, and out of the two-thirds, a very large majority of them are of Muslim faith whose religion encourages polygamy which leads to more births and explains the greater population. The life expectancy in Nigeria is unfortunately the lowest in all 16 West African countries and ranks 178th position in the world because the country has a lot of health issues, where AIDS epidemic, high child and maternal mortality rates are major players, and it has been estimated that one out of every five children born will die due to many health risks while a Nigerian woman's chance of death during pregnancy or childbirth is one out of thirteen.

1.2 Motivation

In Nigeria, Adisa (2019) confirms a more striking finding that growing number of studies conclude that the differences in mortality across different groups have grown significantly. Mortality indicators require attention due to direct implications they have on population size and growth as the reduction in mortality within a nation is a major objective of the government and international organizations. To achieve this goal, indicators of high mortality among disadvantaged people, communities and regions need to be examined and the relationship between the mortality differentials need to be carried out in order to accurately identify how inequalities operate at different levels. According to Antai (2011), marked regional disparities in mortality in Nigeria have been reported with higher rates observed in the Northern Regions than in the Southern Regions, but these were survey reports rather than empirical studies, and the role of explanatory factors was not adequately investigated. In urban or industrialized areas, the incidence of overcrowding and environmental pollution has continued to pose an ever-increasing threat to health. However, the interactions between occupational classes and other socioeconomic factors need to be investigated further. Health inequalities by socioeconomic status have been the subject of intense study in recent years. The availability of services and social amenities in communities or lack thereof may positively or negatively influence the health of the residents, although many studies have reported that less well-educated groups have higher mortality than the better-educated but the exact nature of the association between education and other socioeconomic factors is not yet fully developed. According to Preacely (2012), Nigeria is one of the several WHO regional offices for Africa with no recent and reliable data available on vital events despite the decree of compulsory registration of vital events in 1979, the country has not yet implemented compulsory registration, leading to weakness in the existing mortality report because it is not absolutely possible to generate comprehensive population-based mortality data if most deaths are not even registered.

1.3 Aim and Objective of the Study

This research contributes to the total understanding of the determinants of mortality levels and trends, therefore, the objective of this research is to analyse the mortality differentials in genders, income levels and causes of deaths in order to identify high risk cases towards where health programmes can be channeled or intensified.

1.4 Significance of the Study

Measuring number of deaths each year and why people die are the most important means for assessing the effectiveness of a country's health system to gauge how diseases, injuries and other risk factors affect the people. Cause-of- death statistics help authorities determine the focus of their public health actions. For instance, a country in which deaths from heart diseases and diabetes rise rapidly over a period of a few years will have a strong interest in starting a vigorous programme to encourage lifestyles preventing such illnesses, and similarly, if a country recognises that many children are dying of polio but only a small portion of the budget is dedicated to providing effective treatment, more spending in such area can be worked on. The analysis of mortality differentials provides a basis for policy making that ultimately leads to a decrease in unwarranted deaths and overall development in the quality of life, and also gives insight into why people are dying while exploring some causes of deaths within specific groups or subpopulation. Study of mortality differentials is the study of

differences in death rates in order to identify and address health issues.

1.5 Scope of Delimitation of the study

The research majorly explores mortality differentials in Africa and other continents of the world but pays special attention to situations in Nigeria. The research investigates, examines and analyses mortality differences in the area of gender, income level and cause of death.

1.6 Research Questions

Mortality differentials have widened due to genders, income levels and causes of deaths. In this research, answers will be provided to questions such as: To what extent are there differences in mortality defined by genders, income levels and causes of deaths? How and why does the extent of the differences change in time and vary? The answers to these questions are important from social and health policy perspectives because mortality differentials are useful indicators of health and well-being of population groups.

1.7 Definition of Terms

Mortality differentials: The indicators that measure relative differences in the timing of death between different groups or measure mortality risks of one group relative to another group.

Personal Income level: A person's measure of financial resources.

National income level: The sum of values added by all resident producers plus any product taxes not included in the valuation of outputs plus net receipts of primary income from abroad.

Socioeconomic status (such as income, education, wealth, occupation and so on): Position in hierarchical social structure encompassing notions of class, status, power and also a lifetime access to knowledge, resources and opportunities as they influence exposure to health risks and the ability to seek out treatment.

Deprivation Model: The straightforward economic prediction of the relationship among health, income and education.

2. LITERATURE REVIEW

2.1 Conceptual Review

This research examines mortality differentials in three major areas: gender, income level and cause of death. The educational differentials in the prime working ages are much sharper for males than for females because an obvious explanation for this sex difference is that personal or family economic standing is more closely associated with men than women's education across the global phenomenon as evidence exists in a similar pattern from most countries. In gender mortality differentials, differences occur in the rates of deaths between men and women because each sex category has unique health risks and these health risks directly or indirectly influence mortality greatly. The analysis of female mortality differentials by occupational status is confronted with measurement problems specific to women (Martikainen, 1995). Probably the most severe drawback in using women's own occupational status is that women's careers are, to some extent, related to their marital status and child care responsibilities which make married women move in and out of labour force in order to cope with their household work and childcare responsibilities. Geographical differentials in mortality can be accounted for partly by differences in the compositions and other characteristics of individuals in a particular area or locality. Most often, the higher average income and educational levels favour the urban areas, but the risks connected with urban life (such as pollution, social stress, violence/riot, use of hard drugs, bombing target during war, and so on) reduce the positive effects. Most of the differential indicators impact on each other either positively or negatively. For instance, the level of education can partly explain occupational differentials in mortality because a differentiated increase in the average level of education can impact on trends in occupational differentials. According to World Population Review (2019), the National literacy rate is 59.6% with the average number of years spent in school is approximately 9 years, indicating Nigeria continues to grow faster than many other countries of smaller size but the rate is predicted to be slow somewhat in the coming years with the current rate of 2.6% dwindling to 2.0% by 2050. The

components of population change in Nigeria are: one birth every four seconds (21600births/day), one death every fourteen seconds (6172 deaths/day), one net migrant every nine minutes (-160/ day) and net gain of one person every six seconds.

2.2 Theoretical Review

Study on mortality differentials has long traditions as Herald Westergaard (1901) published a 700-page treatise which summarised the results of hundreds of studies carried out in the nineteenth century (Encyclopedia of Population, 2003). Previous studies have analysed differential mortality by showing associations between the levels of mortality and a multitude of characteristics of areas. Many of these studies (Adegbola (1987); Diderichse & Hallqvist (1997); Taubman & Preston (1994);Martikainen (1995); Manor, Eisenbach, Peritz,& Friedlander (1999)) used estimates of differential mortality from several decades ago. Some of these studies' hypotheses differed about their validity on the causes of mortality differences (Encyclopedia of Population, 2003). Some hypotheses emphasized the causal effects of differences between working classes and living conditions, health related behaviours (such as smoking, alcohol use, diet and so on), the prevalence of psychological stressors or access to health services. Other hypotheses stated that poor health and certain characteristics of individuals (such as social background and intelligence) might affect both socioeconomic positions and risk of premature death. Recent studies have produced new estimates of how mortality differs as well as suggestive evidence that the mortality inequalities have been growing over time, and are broadly consistent in their conclusions based on richer and more recent data than previous estimates and studies of mortality differentials (Goda, Shoven, & Slavov, 2009). Substantial social inequalities leading to mortality differentials have been shown to exist in all countries which have set out to assess the scale of health problems (Son, 2001). The socioeconomic differences between different parts of general population are commonly accepted as the reason why mortality differs (Kaufhold, 2016).

The study of differences in the death rates of specific occupations can be described as the study of occupational mortality, which may refer to the mortality from hazards associated with a particular occupation as an index of social status which shows a widening gap in mortality rates between low and high income groups (Son, 2001). There is a positive relationship between educational acquisition and wage earnings because education is found to reduce the likelihood of household poverty (Adisa, 2019). This appears not to be true in some cases as most educated people are jobless in Nigeria. In pension, it has been observed that the mortality at retirement age within private sector pension plans is higher than that of public sector pension plans due to the fact that public sector workers usually involve in provision of essential services to the general public while the private sector workers do not only provide some essential services but also involve in production and manufacturing using sophisticated tools and machines. These sophisticated tools and machines can lead to occupational hazards, morbidity or mortality and cause the mortality of workers in manual occupations higher than those in non-manual occupations. Some occupations are more risky and create many health problems than others because some industries are clinked with various diseases making death rate in such industries higher. Occupation provides income and good standard of living which are believed to influence death rate, but in all the countries or regions, the occupational mortality rate is different because they have specific social and environmental factors influencing such mortality rate. The increasing mortality in certain occupations as a result of an increasing morbidity may tend to raise the risk of early retirement from some occupations. According to Taubman and Preston (1994), education attainment is an important indicator of mortality differentials as the level of education can partly explain the relationship between occupational classes and the level of mortality. This is not true in all cases because the level of education one obtains may be influenced by a long lasting disability which can affect the occupational mortality differential. In Nigeria, only few studies have presented the relationship between social inequalities in health and work conditions from several points of views such as working environment, women workers and so on. In psychosocial working conditions, the lower social classes suffer higher rates

of psychosocial stress and cardiovascular disease because the more intense job demands and lower decision making requirements are related to increased risks of psychological stress, cardiovascular disease and high blood pressure during working hours (Son, 2001). Hundreds of studies since nineteenth century have shown that married persons live longer than the single, the divorcees and the widows or widowers (Encyclopedia of Population, 2003). Protection and selection effects contribute to the better health of married people, especially female gender. In most cases, healthy people easily get married before people with poor health or disability, and this selection preference into the married state is presumably responsible for longer life of married people. Also the protective effects of the married state associated with financial circumstances (more income and better housing conditions) and healthy behaviours (such as healthier diet, low or no smoking/alcohol consumption) boost life expectant years. On the other hand, the adverse effects of divorce or loss of a spouse account for part of the excess mortality of the divorced and the widowed persons as the high mortality of single people and divorcees may be due to what is referred to as "the broken heart" syndrome. The changes in the economic circumstances associated with the death of a life partner contribute to the relationship between widowhood and mortality. Emphasis on the role of poverty and income distribution on social inequalities reveals that there is a widespread belief that people with low lifetime income have higher age-specific mortality and lower remaining life expectancy at age 60 or 65 than those with middle or high lifetime earnings (Goda et al., 2009). Historically, there was very little evidence to either support or undermine this belief but it is assumed that someone with low income earnings is likely to have poor health as well as high mortality because the rationale for this pattern is that those in higher earning brackets presumably have more opportunities to accumulate savings to salvage unforeseen or unfortunate circumstances as the higher wage rates lead to increasing investment into health related goods and services. Higher income triggers better health and thus lowers mortality due to access to the healthcare system, better knowledge about treatments and stronger adherence to therapies but on the other

hand, when higher income comes at the expense of increased workplace or psychological stress, it could also lead to higher mortality (Horvath & Winter-Ebmer, 2015). For instance, having more sexual partners, life-threatening leisure activities (such as boat cruising, car/bike racing and other hazardous games), alcohol and illegal drug consumptions are pro-cyclical with respect to high income streams. In Africa, according to WHO (2018), stroke and ischemic heart disease were respectively ranked 8th and 9th leading causes of deaths, but in 2015, they were in the 4th and 5th positions respectively while lower respiratory infections, HIV/AIDS and diarrhoea diseases ranked 1st, 2nd and 3rd respectively. Malaria dropped quite substantially in position from being 4th leading cause of deaths in the year 2000 to the 7th position due to the good performance of malaria control programmes in Africa rather than the emergence of other diseases. HIV/AIDS remained the 2nd leading cause of deaths in 2015, but if the current improvements in HIV/AIDS control programmes are sustained, it will not be long before it is eliminated from the group of leading killers in Africa. Mortality from diarrhoea diseases remained largely unchanged in 15 years (2000 – 2015). Road traffic injuries have moved up the ladder from the 13th position in the year 2000 to the 10th position in the year 2015. In the year 2000, road traffic injuries accounted for 1.8% of the deaths, but in the year 2015, it accounted for 2.9% (WHO, 2017). Data from Nigeria suggest influence of urbanization and industrialization on health conditions (Adegbola, 1987). Pollution from industrial effluent and smoke as well as from traffic emission form a regular feature of Nigerian cities contributes to early mortality in urban or industrialized areas. Premature deaths and higher prevalence of illness have been linked to a number of different drivers of mortality and morbidity such as limited access to healthcare, less awareness of healthy behaviour/nutrition, the individuals' disadvantaged living/working conditions, and all these factors are in turn closely correlated with the levels of education, the wealth of an individual and the persons' social context. According to the Nigerian Demographic & Health Survey (2018), previous survey revealed that maternal deaths accounted for 32% of all deaths among women aged 15-49, making the maternal mortality rate 1.05 maternal deaths per

1000 woman-years of exposure where the maternal ratio was 576 maternal deaths per 100 000 live births in the year 2005, although there has been an improvement in Nigeria but it is slow as the recent survey and indicators show that the ratios are not largely or significantly different. National income level can either be calculated or converted to U.S dollars (Atlas Method) or international dollars (Purchasing Power Parity Method). Generally, there is an observable trend that mortality is higher among the lower income classes. Back in the 20th century, this difference was very high with a much higher percentage of impoverished population dying per year than the wealthy population. People with less money are at higher risk due to poorer hygiene, less access to preventive medicine, low quality of food and even the risk of manual labour in some places especially in rural areas where there are regional and social inequalities, but better access to healthcare can gradually offset the differences. There exists an inverse relationship between income and mortality as those who fall in the lower income group are likely unable to share the amenities or facilities provided within a rich society and also unable to fulfill the social and occupational obligations placed upon them by virtue of their limited resources (Diderichse & Hallqvist, 1997).

2.3 Empirical Review

Using a wide range of socioeconomic measures, a copious body of empirical literature has firmly established the existence of substantial inequalities in mortality rates (Bosworth, 2018). Analyses are typically based on broad occupational categories as research into mortality by occupation has focused on the proportional mortality ratios which identify the causes of deaths that are over-represented in specific occupations. Such research is helpful in detecting what diseases or risks are most likely to be present in different groups, but does not provide information about how absolute mortality rates differ between occupations and it is therefore of little use to informed broad policy choices. Although mortality differences are well pronounced in the active ages but this does not mean that differentials in mortality do not exist or are not still found in the old age group as accumulated wealth, past occupational risk exposure, healthy living and information still play major role on longevity

(Marmot, Rossum, Shipley, Mheen, & Grobee, 2000). Most studies on mortality differentials have focused on developed countries due to availability of analytical data on such countries, but there have been little such studies on developing countries, such as Nigeria. Furthermore, a broader picture of the relationship between socioeconomic determinants or indicators, taking into account whole national population, has not been developed either in most developing countries. This study attempts to fill the gap of mortality differentials in several senses in Nigeria as it deals with effects of deaths on the population.

3. RESEARCH METHODOLOGY

3.1 Research Design

In recent years, there have been inconsistencies and differences in the use and interpretation of available data on mortality. This research has been designed to maximize the consistencies and minimize the differences through the help of data from the national and international organisations such as World Health Organisation (WHO), United Nations (UN), Federal Bureau of Statistics (FBS), Nigerian Demographic & Health Survey (NDHS) and others. As most data are generally drawn from surveys, the reliability of the estimates from the surveys depend upon the overall quality of the sampling frames and methods used to carry out such surveys. Many underdeveloped or developing countries including Nigeria lack adequate and vital health information systems they need to accurately and effectively monitor health trends for health policies and decision making. The research used descriptive and inferential statistics strategically to derive change.

3.2 Method of Data Collection

In the course of this study, visits were made to hospitals, friends and family members for personal observations, investigation and data collection in order to have comprehensive knowledge on the subject matter. The secondary data were obtained from the periodic reports, forums, articles, textbooks, paper presentations, journals publications, surveys of health and health related organisations.

Table 1: *Nigeria Life Expectancy (2006-2018)*

Year	Male	Female	Both
2018	54.7	55.7	55.2
2017	53.1	54.7	53.9
2016	52.7	54.2	53.4
2015	52.2	53.8	53.1
2014	51.8	53.3	52.6
2013	51.4	52.9	52.2
2012	50.9	52.4	51.7
2011	50.6	51.9	51.3
2010	50.1	51.6	50.8
2009	49.7	51.1	50.4
2008	49.1	50.6	49.9
2007	48.6	50.1	49.4
2006	48.1	49.6	48.8

SOURCES: *https://worldlifeexpectancy.com/nigeria-life-expectancy*
https://data.worldbank.org/indicator

3.3 Method of Data Analysis

This research employed both descriptive and inferential statistics as analytical/statistical tools. The descriptive statistics were used to analyze cause-of-death and income group differentials while both the inferential and descriptive statistical tools were used to analyze gender differential.

3.4 Model Specification

The least square method of regression analysis was used to investigate the future relationship estimate or trend between the gender variables in mortality and life expectancy. The regression analysis is of utmost importance in predicting and improving knowledge of variables of interest (Mojekwu, 2012). In *Table 1*, the trend is linear. Hence the equation of the linear trend is defined as:

$$\hat{Y} = a + b X \qquad (1)$$

Where:

$X=$ transformed time

$\hat{Y}=$ the estimated trend value for a given period

$a=$ value of the trend line at time zero

$b=$ the slope of the trend line (i.e. the change in $\hat{Y}$ per unit change in time)

The constants *a* and *b* can be calculated using:

$$b = \frac{n\sum XY - \sum X\sum Y}{n\sum X^2 - (\sum X)^2} \qquad (2)$$

$$a = \frac{\sum X^2 \sum Y - \sum X\sum XY}{n\sum X^2 - (\sum X)^2} \qquad (3)$$

At $\sum X = 0$;

$$b = \frac{\sum XY}{\sum X^2} \qquad (4)$$

$$a = \frac{\sum Y}{n} \qquad (5)$$

3.4.1. Test of reliability of the model

Standard Error of the Estimate (S_e)

S_e is a measure that assesses the reliability of the result obtained. It measures the variability or scattering of the observed values around the regression line. It is evaluated using the formula below.

$$S_e = \sqrt{\frac{\sum(Y - \hat{Y})^2}{n-2}} \qquad (6)$$

4. DATA PRESENTATION AND ANALYSIS

4.1 Gender Differentials

A direct observation from *Table 1* and according to facts/figures available indicate that male mortality and life expectancy are respectively higher and lower in male at all ages when compared to the female mortality and life expectancy in Nigeria. In Nigeria, males live on average of 53.7 years while the females live 55.4 years because some activities, habits, behaviours, diseases or accident cases are common in males than in females (World Population Review, 2019). According to the National Bureau of Statistics and the United Nations Children's Fund (2018), the use of tobacco and alcohol is higher among Nigerian men than women as 6.9% and 19.4% of men use tobacco and alcohol products respectively while 0.3% and 6.4% of women use tobacco and alcohol products respectively. The severity and frequency of the risk factors that bring about differences in the mortality rates and life expectancy of males and females are due to some societies consider some constructed roles, behaviours, activities and attributes appropriate for males and females. The higher the mortality of one gender, the lower the life expectancy of that gender. There exists an inverse relationship between mortality rate and life expectancy. Both male and female have unique health risks and these risks greatly influence the expected years lived. Most males suffer more from ischemic heart disease, road injuries, lung cancers, chronic obstructive pulmonary disease, stroke, cirrhosis of the liver, tuberculosis, prostate cancer, interpersonal violence, liver cancer, stomach cancer, lower respiratory infections, self-harm, oesophagus cancer, HIV/AIDS or kidney diseases, while females, on the other hand, suffer more from breast cancer, maternal conditions, cervix uteri cancer. In Nigeria, it was estimated that 12% of women between ages 15 and 50 were likely to die within 2008 and 2013 but mortality decreased by 25% as one in thirty women within this age range died as a result of maternal conditions such as pregnancy and child bearing issues (Demographic and Health Survey, 2018).

Male Life Expectancy

Table 2: *Computations on Male Life Expectancy (2006 – 2018)*

Year	Life Expectancy (Y)	Transformed Time Trend (X)	XY	X²	Ŷ	(Y –Ŷ)²
2006	48.1	-6	-288.6	36	48.0924	5.776E-05
2007	48.6	-5	-243	25	48.577	0.000529
2008	49.1	-4	-196.4	16	49.0616	0.0014746
2009	49.7	-3	-149.1	9	49.5462	0.0236544
2010	50.1	-2	-100.2	4	50.0308	0.0047886
2011	50.6	-1	-50.6	1	50.5154	0.0071572
2012	50.9	0	0	0	51	0.01
2013	51.4	1	51.4	1	51.4846	0.0071572

Year	Life Expectancy (Y)	Transformed Time Trend (X)	XY	X²	Ŷ	(Y – Ŷ)²
2014	51.8	2	103.6	4	51.9692	0.0286286
2015	52.2	3	156.6	9	52.4538	0.0644144
2016	52.7	4	210.8	16	52.9384	0.0568346
2017	53.1	5	265.5	25	53.423	0.104329
2018	54.7	6	328.2	36	53.9076	0.6278978
	$\sum Y = 663$	$\sum X = 0$	$\sum XY = 88.2$	$\sum X^2 = 182$		$\sum = 0.936923$

In this section, *Table 1* was analyzed by using least square method in relation to equations *(1)* to *(6)* already stated in the previous section.

From equation *(5)*,

$$a = \frac{663}{13} = \mathbf{51}$$

Using equation *(4)*,

$$ь = \frac{88.2}{182} = \mathbf{0.4846}$$

From equation *(1)*,

$$\hat{Y} = 51 + 0.4846\,X \tag{7}$$

From equation *(6)*

$$S_e = \sqrt{\frac{0.9369231}{11}} = 0.2918$$

The standard error rate of **0.2918** with variance of *0.0852* shows the result is reliable. Therefore, prediction from this result should be used with high confidence.

Female Life Expectancy

From equation *(5)*,

$$a = \frac{681.9}{13} = \mathbf{52.4538}$$

Using equation *(4)*,

$$ь = \frac{86.5}{182} = \mathbf{0.4753}$$

From equation *(1)*,

$$\hat{Y} = 52.4538 + 0.4753\,X \tag{8}$$

Table 3: *Computations on Female Life Expectancy (2006 – 2018)*

Year	Life Expectancy (Y)	Transformed Time Trend (X)	XY	X²	Ŷ	(Y – Ŷ)²
2006	49.6	-6	-297.6	36	49.602	4E-06
2007	50.1	-5	-250.5	25	50.0773	0.000515
2008	50.6	-4	-202.4	16	50.5526	0.002247
2009	51.1	-3	-153.3	9	51.0279	0.005198
2010	51.6	-2	-103.2	4	51.5032	0.00937
2011	51.9	-1	-51.9	1	51.9785	0.006162
2012	52.4	0	0	0	52.4538	0.002894
2013	52.9	1	52.9	1	52.9291	0.000847
2014	53.3	2	106.6	4	53.4044	0.010899
2015	53.8	3	161.4	9	53.8797	0.006352
2016	54.2	4	216.8	16	54.355	0.024025
2017	54.7	5	273.5	25	54.8303	0.016978

2018	55.7	6	334.2	36	55.3056	0.155551
	$\sum Y=681.9$	$\sum X = 0$	$\sum XY=86.5$	$\sum X^2=182$		$\sum=0.241044$

From equation (6)

$a= \dfrac{672.7}{13} = \mathbf{51.7462}$

$S_e = \sqrt{\dfrac{0.241044}{11}} = 0.148$

Using equation *(4)*,

The standard error rate of **0.148** with error probability of *2.19%* suggests the prediction from this result is reliable.

$b = \dfrac{87.5}{182} = \mathbf{0.4808}$

Life Expectancy of both Genders

From equation *(1)*,

From equation (5),

$\hat{Y} = 51.7462 + 0.4808\,X \qquad (9)$

Table 4: *Computations on both Life Expectancy (2006 – 2018)*

Year	Life Expectancy (Y)	Transformed Time Trend (X)	XY	X^2	$\hat{Y}$	$(Y-\hat{Y})^2$
2006	48.8	-6	-292.8	36	48.8614	0.00377
2007	49.4	-5	-247	25	49.3422	0.003341
2008	49.9	-4	-199.6	16	49.823	0.005929
2009	50.4	-3	-151.2	9	50.3038	0.009254
2010	50.8	-2	-101.6	4	50.7846	0.000237
2011	51.3	-1	-51.3	1	51.2654	0.001197
2012	51.7	0	0	0	51.7462	0.002134
2013	52.2	1	52.2	1	52.227	0.000729
2014	52.6	2	105.2	4	52.7078	0.011621
2015	53.1	3	159.3	9	53.1886	0.00785
2016	53.4	4	213.6	16	53.6694	0.072576
2017	53.9	5	269.5	25	54.1502	0.0626
2018	55.2	6	331.2	36	54.631	0.323761
	$\sum Y=672.7$	$\sum X = 0$	$\sum XY=87.5$	$\sum X^2=182$		$\sum=0.505$

From equation (6)

$$S_e = \sqrt{\frac{0.505}{11}} = 0.2143$$

The 4.59% variance and the standard error of **0.2143** indicate the prediction result is reliable with low deviation.

Future Estimates of Life Expectancy in Nigeria

The computation results in equations *(7), (8)* and *(9)* make it easy to estimate future life expectancy as shown in *Table 5*.

Table 5: *Life Expectancy Estimates for the Year 2025*

Gender	Regression Equation	Probability Error	Transformed Time (X)	Life Expectancy (Y)
Male	$\hat{Y} = 51 + 0.4846\,X$	0.0852	13	57.30
Female	$\hat{Y} = 52.4538 + 0.4753\,X$	0.0219	13	58.63
Both	$\hat{Y} = 51.7462 + 0.4808\,X$	0.0459	13	58.00

4.2 Income Group Differentials

Table 6 shows African countries and their income level details. Nigeria belongs to lower middle group based on GNI/Capita income level distributions.

Table 6: *African Countries by Income Levels*

Income Level	Countries
High income countries (GNI/capita>12,055)	Seychelles
Upper middle income countries (GNI/capita 3,896-12,055)	Algeria, Botswana, Equatorial Guinea, Gabon, Mauritania, Namibia.
Lower-middle income countries (GNI/capita 996-3,895)	Angola, Cabo Verde, Cameroon, Congo, Côte d'Ivoire, Eswatini, Ghana, Kenya, Lesotho, Mauritania, Nigeria, Sao Tome and Principe, Mauritania.
Low income countries (GNI/capita<996)	Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Eritrea, Ethiopia, Gambia, Guinea-Bissau, Guinea, Liberia, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, South Sudan, Tanzania.

Source: Country Income Groups (World Bank Classification). Available online at: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups. Accessed on 25th April 2019

Nigeria ranks 147th position (Atlas Method) and 141st position (PPP Method). Out of the 54 countries in Africa, 47 are classified as Sub-Sahara African countries. According to World Bank classification, twenty-seven (57.4%) of the Sub-Sahara African countries are low income countries, thirteen (27.7%) belong to lower middle income, six (12.8%) are upper middle income countries, while one country, Seychelles, is a high income country.

From *Table 7*, at age 60, African Health-Adjusted Life Expectancy (HALE) is 12.5 years compared to 12.9 years of low income countries. This difference is minute but it will not be wrong to conclude that most African countries are in lower income group. At higher ages, there will be no significant difference in life expectancy in the world because life expectancy at birth (62.7 years) in low income countries is 18.1 years lower than high income countries (80.8 years), but at age

60, the difference between the life expectancy of lower middle and upper middle income has reduced from 7.3 years (at birth) to 2.2 years, thereby signifying that the gap in life expectancy begins to close up with the increase in age, irrespective of income levels. In high income countries, most people who die are old while almost one in three deaths is young person in low income countries.

Table 7: *Life Expectancy and World Bank Income Group, 2016*

		Life expectancy	HALE	Life expectancy	HALE
		At birth (years)		At 60 years (years)	
Global	Male	69.8	62.0	19.0	14.8
	Female	74.2	64.8	21.9	16.8
	Both sexes	72.0	63.3	20.5	15.8
WHO region (both sexes)	AFR	61.2	53.8	16.6	12.5
	AMR	76.8	67.5	22.7	17.6
	SEAR	69.5	60.4	18.2	13.3
	EUR	77.5	68.4	22.3	17.4
	EMR	69.1	59.7	18.2	13.3
	WPR	76.9	68.9	21.0	16.6
World Bank income group (both sexes)	LI	62.7	54.9	17.1	12.9
	LMI	67.9	59.1	18.0	13.2
	UMI	75.2	67.0	20.2	15.8
	HI	80.8	71.2	24.3	19.0

Source: W.H.O. (2018)

The differences in life expectancy between males and females are smaller in low income countries than in higher income countries, as communicable diseases, injuries and maternal conditions contribute most to differences in lower income countries while non-communicable diseases contribute most to the higher income countries. In other words, maternal deaths are associated with lower income group as a result of inadequate access to essential health services. The life expectancy of males is lower than that of females due to higher mortality rates from most causes, particularly in high income countries. In low income countries, the net effect of maternal conditions, breast and cervical cancers reduces the differences in life expectancy, compared with high income countries. Low income countries has the highest mortality rate due to road traffic injuries with 29.4 deaths per 100 000 population, compared to global rate of 8.8. Careless driving, bad roads, roadworthiness of vehicles and inefficient traffic officers cannot be ruled out in this. Road traffic injuries were also among the leading causes of deaths in lower-middle and upper-middle income groups, claiming 4.9 million lives in 2016 (WHS, 2019).

4.3 Cause-of-Death Differentials

Table 8 shows top ten diseases and the mortality risk factors (MRF) in Nigeria. Prior to the Year 2008, the number one cause of premature death was malaria, which dropped down in 2017 due to awareness campaigns and distribution of mosquito nets by the Nigerian Federal Ministry of Health and other Non-Governmental Organisations (NGOs).

Malnutrition, ascribed to abject poverty in some places or households, is the number one factor of mortality risks which is common among children, especially during civil unrest and terrorist attacks in Nigeria. The geographical region mostly affected is the Northern Nigeria as shown in Demographic and Health Survey (2018). Air pollution is common in urban areas due to large concentration of industries, factories and vehicular movement.

Globally, of the 56.9 million deaths worldwide, more than half (54%) were due to the top ten causes as ischemic heart disease and stroke are the world's biggest killers, accounting for a combined 15.2 million deaths. Heart diseases occur when

arteries become clogged with fatty materials. Both heart diseases and stroke are vascular events which involve blood vessels and the arteries in particular. The notable causes are psychological stress or depression, diabetes (blood sugar), high blood pressure, high cholesterol and obesity. These diseases have remained the leading causes of deaths in the last 19 years (WHO, 2019). Lung cancer caused 1.7 million deaths while diabetes killed 1.6 million people in 2016, compared to less than 1 million deaths in the year 2000, but lower respiratory infections (LRIs) remain the most deadly communicable disease, causing 3 million deaths worldwide.

Table 8: *Top 10 Causes of Deaths in Nigeria and Mortality Risk Factors (MRF)*

CAUSES	RANKING		MRF	RANKING
	2007	2017		
Lower Respiratory Infection	4	1	Malnutrition	1
Neonatal Disorder	5	2	Wash	2
HIV/AIDS	3	3	Air Pollution	3
Malaria	1	4	Unsafe Sex	4
Diarrhoea	2	5	High Blood Pressure	5
Tuberculosis(T.B)	6	6	Alcohol Use	6
Meningitis	7	7	Dietary Risks	7
Ischemic Heart Disease	9	8	High Fasting Plasma Glucose	8
Stroke	10	9	Tobacco	9
Cirrhosis	8	10	Drug Use	10

Sources: Institute for Health Metric and Evaluation (IHME),2018.
www.cdc.gov/globalhealth/countries/nigeria   www.healthdata.org/nigeria

Table 9: *Deaths by Regions (in thousand).*

Region	Year		
	2000	2015	2016
South-East Asia	13,041	13,836	13,819
Western Pacific	10,699	13,309	13,779
Europe	9,439	9,279	9,215
Africa	9,793	9,207	8,845
Americas	5,592	6,575	6,876
Eastern Mediterranean	3,400	4,023	4,122

Data source: W.H.O. (2015 & 2018)

Table 10: *Percentage of Deaths by Main Causes in Africa*

Cause of Deaths	Year	
	2000	2016
Lower respiratory infections	10.6	10.4
HIV/AIDS	12.2	8.1
Diarrhoeal diseases	9.7	7.4
Ischaemic heart disease	3.8	5.8
Malaria	7.3	4.6
Tuberculosis	4.0	4.6
Stroke	3.1	4.2
Preterm birth complications	3.9	3.9
Birth asphyxia and birth trauma	3.8	3.7
Road injury	1.8	3.2
Protein-energy malnutrition	2.3	2.4
Maternal conditions	2.4	2.2
Congenital anomalies	1.5	2.1
Meningitis	2.5	2.1
Neonatal sepsis and infections	1.6	2.0
Cirrhosis of the liver	1.4	2.0

HIV/AIDS is no longer among the world's top ten causes of deaths due to role of medicine, discoveries or breakthrough in medical researches, having killed over 1.5 million people in the year 2000. Road injuries killed 1.4 million people which about three-quarters (74%) of whom were men and boys.

Ischemic heart disease and stroke are the world's biggest killers but this is not the case in Africa (Atlas of African Health Statistics, 2019). From *Table 10*, ischemic heart disease and stroke were ranked 7th and 8th leading causes of deaths respectively in the year 2000, but in the year 2016, they were in the 4th and 7th positions respectively, both accounting for 10% of all deaths. In the year 2015, malaria was ranked the 7th leading cause of deaths in Africa but in the year 2016, it moved to 5th position. In agreement to WHO (2017) & WHO (2018), diarrhea disease's position in the leading causes of deaths remained largely unchanged in 16 years (2000 – 2016), and HIV/AIDS remained the 2nd leading cause of deaths. In the year 2016, there were estimated 8.8 million deaths in the African region where lower respiratory tract infections killed the most as about one in ten of the deaths (10.4%) was due to lower respiratory tract infections while HIV/AIDS killed about 716 454 people (accounting for 8.1% of the total deaths). This was followed by diarrhea disease (7.4%) and ischemic heart disease (5.8%). Tuberculosis remained in the 6th position among the top 10 killers in Africa, accounting for 406 870 deaths (4.6%). Death from road traffic injuries has continued to increase because in the year 2000, road traffic injuries accounted for 1.8% of the deaths while it accounted for 3.2% of the all deaths in 2016.

5. DISCUSSION OF FINDINGS, CONCLUSION AND RECOMMENDATION

5.1 Discussion of Findings

Based on the data collected, analysed and used in the course of this research, the following findings were discovered.

i.   Mostly, poor people suffer ill health and premature deaths because poverty and low status exact a health toll through absolute deprivation of material resources as life will be short when its quality is poor.

ii. It's been consistent factor across history that the mortality for men is higher than women as more men die per year than women. Historically, female mortality was mostly due to childbirth but women's lives were usually spared during war while men usually got murdered. Mortality in men arises from many sources predominantly linked to their daily activities/occupations, fatal diseases and medical conditions like heart failure.

iii. This study has identified high risk groups or cases to which health programmes can be most efficiently directed in addition to preventing and checking these high risk cases by healthy life choices which include: avoiding smoking and caffeinated drinks; eating healthy food (avoiding processed or fatty food); maintaining healthy weight; managing stress (muscular relaxation, breathing techniques or visualizations); and being active (such as exercising and moving more).

iv. HIV/AIDS or malaria is no longer a major killer disease in the developed countries due to the role of medicine and recent health discoveries, but these diseases are still killer diseases in some underdeveloped or developing countries like Nigeria.

v.   Many countries, including Nigeria, lack adequate or accurate data and health information systems, making numbers of deaths arising from different health risks or factors to be estimated mostly from incomplete data.

5.2 Conclusion

It is a common knowledge that everybody will eventually die but not everybody will die at the same time and for the same reason. Some people die early although they seemed to live healthy lifestyles, whereas others die old despite certain risky

situations surrounding them. Nevertheless, the explanation of the mortality differentials among groups of people depends upon the strength of the association between risks and health factors. Despite the fact that several indicators have been used in studies of differentials in mortality, information about these differentials is not usually available in regular statistics because the ordinary sources of mortality statistics do not often include reliable information on the characteristics of deceased persons, especially in rural areas of the underdeveloped and some developing countries like Nigeria. Most knowledge about differences in mortality comes from studies for which data have been specifically collected for an analysis of differences and despite the measurement problems, there is abundant evidence from different periods and countries that persons in lower economic positions die, on the average, younger than those higher economic positions.

More than half of all deaths in low income countries are caused by communicable diseases, maternal causes and conditions arising during pregnancy or child birth and nutritional deficiencies. By contrast, less than 10% in high income countries are due to such causes as non-communicable diseases (NCDs) caused about 71% of deaths globally, ranging from about 37% in low income group to about 88% in high income group. It was observed that LRIs were among the leading causes of deaths across all income groups. 78% of global NCD deaths occurred in low and middle income countries. It must be noted that most deaths in lower income group are due to causes that are frequently preventable or treatable through access to basic health services, while most deaths in high income countries are frequently associated with environmental factors or natural disasters. As social economic status rises, rate of mortality falls and vice versa. It should also be noted that irrespective of the measure of social position used, disadvantaged social groups will have a lower life expectancy and a greater risk of premature death. This research investigated sex mortality differentials and showed that females live longer than males but the additional years are not always healthy because females survive to ages where most diseases commonly occur, and hence the absolute difference in the life expectancy decreases with age as the ratio

of the number of men alive to the number of women changes through the life course but deaths before age 60 are more common among males than females. Behavioural factors have a major impact on differences in survival by sex as cigarette smoking, alcohol abuse, aggressive driving and exposure to occupational hazards are more common among men. Females' higher survival is due partly to biological factors as women are less likely, than men, to develop cardiovascular diseases because their sex hormones are believed to play a major role in this.

Heart diseases and stroke are the principal causes of deaths responsible for social class differences in mortality from all causes combined and the biggest cause of death from heart diseases and stroke is the progressive blocking of blood vessels with a building-up of fatty substances and cellular wastes (plagues). Plagues build-up in the arteries supplying blood to the heart muscles can trigger angina or a heart attack, while plagues build-up and blood clots in arteries supplying blood to the brain can cause a stroke. In African region, proportional mortality from lower respiratory tract infections, diarrhea disease, birth asphyxia & trauma, and preterm complications remained largely unchanged in 16 years (2000 – 2016). Also, this study has assessed variations in the risks of mortality in Nigeria as the rampant AIDS epidemic is still a very big killer but government and international organizations are taking steps to help fight the epidemic. Fortunately, out of 3.1 million residents (about 2% of the Nigerian population) living with HIV/AIDS in the country, the numbers have improved significantly over the last 15 – 20 years (World Population Review, 2019).

5.3 Recommendation

Based on the findings arising from this study, the following recommendations are offered.

i. Special interventions are needed to face up to the challenge to avoid a significant increase in poverty level. In order to minimize the differences in health outcomes and maximize the health gains between lower income and higher income groups, responses

that are aimed at mitigating exposure to risk factors and/or adequate access to health services should be employed to bridge the widening disparities among the poor, the rich and those in-between.

ii. Greater efforts are needed to prevent road traffic injuries which are on the rise and causing more deaths among males. To reduce the differences in sex mortality rates, systems should be put in place for collecting information on causes of deaths or sex mortality determinants in order to identify how inequalities operate at different levels or regions while laying more emphasis on the role of medicine, importance of public health care services, effects of alcohol, anti-smoking campaign and so on.

iii. The risk of heart disease and stroke can be reduced by having regular medical check-ups and making healthy life choices. People should measure their body mass index, blood sugar level, waist circumference, cholesterol level, stress level and pulse rate at regular interval or at least once a year. Special efforts are required to curb those infections and diseases whose proportional mortality remains largely unchanged for a considerable number of years.

iv. The review of mortality differentials carried out in this study provides a basis for policy making that ultimately leads to a decrease in unwarranted deaths and overall development in the quality of life. Vigorous health programmes to encourage lifestyles

that prevent illnesses and more budgetary spending in such area should be the focus of public health actions in order to provide effective treatments.

v. Anti-AIDS and anti-malaria campaigns should be intensified in Nigeria and Africa as a whole while research that helps to understand the specific organisms responsible for the causes of deaths from diseases and infections should not only be embarked on but also implemented.

vi. Quality data are crucial in any research for improving health decisions and reducing preventable deaths. High quality data system should be taken seriously and improved upon because with right health information, diseases can be prevented, cured or treatable easily.

5.4 Suggestion for Further Research

There is considerable room for further research on mortality differentials in adult or active population in Nigeria as it will be very fascinating to consider the working population of this cohort according to sectored divisions (private and public). It will be point of interest to know the contributions of each sector or division of the economy to the mortality differential determinants or indicators rather than combined contributions which may distort conclusion. Comprehensive data on these sectors or divisions are not reliably available in Nigeria at the moment and therefore, further work on this area will be certainly warranted.

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