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Human Ageing, Mortality and the Role of Macroeconomics Variables in Determining Death at Older Ages

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Abstract

Introduction: Human death is an old phenomenon that changes in degree over the centuries owing to the age structure, diseases, technology, discoveries and information as well as public health measures. Long before the invention of penicillin and the scientific revolution, pandemic and pestilence accounted for most human deaths, and the life expectancy was less than 40 years.

Objectives: This study aims to 1) evaluate the influence of particular macroeconomic conditions on mortality at older ages (60+), 2) model factors on deaths at older ages, 3) examine mortality at older ages, 4) determine the gender composition of mortality at older ages, and 5) provide public health administrators with pertinent information that will aid policy development and formulation.

Methods: This work utilized mainly secondary data analysis. Data were collated from various Jamaican Government Publications, namely Jamaica Survey of Living Conditions, Economic and Social Survey of Jamaica, Bank of Jamaica demographic statistics and the International Monetary Fund statistics. Ordinary least square regression was used to analyse the data.

Results: Of the five (5) macroeconomic variables examined in this paper (inflation, unemployment, poverty, GDP and exchange rate); unemployment, GDP per capita and the annual exchange rate are correlated with mortality at older ages. Poverty and inflation directly impact on mortality at older ages.

Conclusion: Death at more advanced ages is equally an economic phenomenon as it is a biological issue, and the new findings provide insights into the economics of mortality at older ages.

Keywords: Ageing; Fatality; Macroeconomic variables; Public health; Transience; Jamaica

Introduction

Human death is an old phenomenon that changes in degree over the centuries. The change is as a result of the age structure, diseases, technological advancements, discoveries and access to information as well as public health measures. Long before the invention of penicillin and the scientific revolution, pandemic and pestilence (or plagues) accounted for most human deaths, and life expectancy did not surpass 40 years. It was during the Middle Age that the Oriental or Bubonic plague (a rate-based disease, fleas that lived on humans and rats) accounted for most of human's mortality [1-10]. In fact, in early 1330s, this disease destroyed many lives in Hong Kong and later spread throughout China and the continent of Asia before travelling to Europe. It was in October 1347 that this pestilence was brought to Europe by a group of Italian merchants who had travelled to China on business [11,12]. On their return to the ports of Sicily, many of them were found suffering from the plague and soon after succumbed to its deadly grip. The pestilence had travelled all the way through northern Europe to England. In August of the fourteenth century (1348), the people of England named it the '*Black Death*' [11-13]. It had resulted in the death of approximately 50 million lives in Europe and Asia [11]. One scholar opined that this disease 'wiped out' about one-third to one-half of European's and Asian's human population and within five years it had slaughtered 25 million Europeans. The disastrous bubonic plague continued for centuries before it disappearance in the 1600s. It was during this time that the study of demography was born, which was credited to John Graunt [11].

Using mortality data for London in the seventeen century, John Graunt forwarded that social statistics can be used in public administration. He empirically established the scientific study of population (now known as demography) based on causes of death, proportions of people surviving at different ages, age structure, population estimates, population growth and its components among other population measures [14]. According to Rowland [12], the last disastrous plague to have taken place in London was in 1665, which John Graunt had lived through in order to have made his contribution to the study of demography. It was also during the 1700s that the well- known disease, smallpox, accounted for an estimated 100 million human deaths worldwide. Later on in 1899 Hawaii experienced an outbreak of a plague, ascribed to Oahu's Chinatown that was brought to the United States which also resulted in huge losses of human lives. Whereas low mortality is not synonymous with all nations-because of warfare famine and issues of poverty-low death rates have been the experience of a

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plethora of people in developed societies after the discoveries of the penicillin in the 1920s along with proper sanitation and public health measures. Many developing and emerging nations have trailed behind the developing world in achieving lower death rates, but on the whole mortality rates have improved. Accompanying mortality decline is the issue of the fertility transition that began in 19th century France.This has spread throughout Europe, North America, portions of Asia and the Caribbean to name a few regions. According to the Centers for Disease Control and Prevention (CDC), "In the United States, the last urban plague epidemic occurred in Los Angeles in 1924-25. Since then, human plague in the United States has occurred as mostly scattered cases in rural areas (an average of 10 to 15 persons each year)" [1].

The shifting of mortality away from communicable diseases to non-communicable conditions has resulted in increased life expectancies of people across the globe. Declining mortality has birthed the next inevitable population challenge, old age. Population ageing is not simply a function of quantity of years but also quality of life. The stark reality is the number of persons living longer has increased and this increase in the number of aged in the population corresponds with the increased incidence of age related health challenges not just for individuals but the society. This challenge is compounded by the possibility of reduced economic growth, shifts in disease patterns and prevalence. There is a higher probability of increasing the pressure on the working age population owing to the sheer number of the aged population. This will mean increased taxes, social support, health costs and reductions in the labour supply. Empirical evidence has established that mortality increases with ageing, particularly beyond 60 years [11,14-17]. The World Health Report stated that "42% of adult deaths occur after 60 years of age in developing countries, compared with 78% in the developed world" [15]. It can be deduced from the findings of the WHO that mortality at older ages (60+years old) is greater than for those at younger age cohorts, and this is even increasingly larger especially among those 80+ years old that are actively ageing as people approach their lifespan. Active ageing is defined as "the process of optimizing opportunities for health, participation and security to enhance quality of life as people" [16], suggesting that an examination of mortality data will provide an understanding of how to enhance health status of population, moreso for the aged which goes to the issue of life expectancy that emerged from mortality data.

Dating back to John Graunt, mortality was among the first area in the study of population phenomenon as it provided an insight to life expectancy, health status and future population characteristic. There is no denial that mortality statistics opens a revelation to the core of health statistics, population forecasts and projections, and thereby justifies its importance in governments planning. While a study by Bourne and co-authors found that health status decreases with aged Jamaicans as well as a rise in chronic conditions-diabetes, hypertension and arthritis-which account for higher deaths at older ages, the factors which influence poor health status of the aged included 1) medical expenditure (b=0.135, P<0.05); 2) marital status (married: b=0.341, P<0.05; divorced, separated or widowed: b=0.634, P<0.05); 3) house tenure (rent free or squatting: b=-0.282, P<0.05); 4) education 5) gender (female: b=-0.553, P<0.05); 6) psychological conditions (negative: b=0.035, P<0.05; positive=-0.056, P<0.05), and ownership of durable goods (b=-0.048, P=0.05) [17,18]. Despite the significance of mortality statistics as well as poor health status to public health, epidemiology and demography, there is a paucity of empirical works that have examined in a single study mortality and economics, particularly the influence of inflation, exchange rate, Gross Domestic Product (GDP), unemployment and poverty on deaths among people 60+ years old in the English-Speaking Caribbean.

Empirical studies having established the correlation between inflation and health care utilization [18] as well as the influence of poverty of health care utilization [19], within this context the elderly demands health care owing to the degeneration of their bodies, then an examination of macroeconomic conditions would provide critical information to the health literature as well as mortality studies. There is a health transition which occur during ageing, particularly at older ages [20,21] as the human cell degenerate with ageing [22,23], which indicates an inquiry into mortality at older ages is valuable to the health discourse. However, there is no information in the literature on the macroeconomic environment on mortality at older ages, particularly in developing nations with an ageing population. The present paper aims to 1) evaluates the influence of particular macroeconomic conditions on mortality at older ages (60+), 2) model the conditions of the various factors on deaths, 3) examines mortality at older ages, 4) determine the gender composition of mortality at older ages, and 5) provide public health administrators with pertinent information that will aid policy development and formulation.

Theoretical Framework

Strehler-Mildvan theory

The fundamental theoretical framework that underpins this study is one developed Strehler and Mildvan on the general theory of mortality and aging [24], and later modified by Zheng and co-authors [25]. The empirical work of Strehler and Mildvan is based on:

1) Gompertz's Law of Mortality that forwards that the exponential increase of adult human mortality with age t,

$$R_t=R_0^{ea}=0 \quad (1)$$

with

2) a linear decline of vitality index (1) $V_t=V_0$ (1-Bt) with increasing age, where vitality V_t is the capacity of an individual organism to stay alive at age t, and the attrition coefficient B is the fractional loss each year of original vitality V_0, and

3) Parameters measuring environmental stresses- a measure of the frequency of environmental variations K and a measure of their average magnitudeε D.

Strehler and Mildvan's work [24] was based on the logarithm of Gompertz' Law of Mortality- SM correlation ($\ln R_0=-1/B\alpha+\ln K$) being the intercept $\ln R_0$ and the gradient α of the logarithm of the Gompertz mortality curve are inversely associated - which led to the proposition that human mortality will rise irrespective of living standard, health care and other factors. In keeping with Strehler and Mildvan's work, Zheng and co-authors applying the same mathematical principle examined many variables of which the following emerged as statistical significant factors 1) industry structure (water pollution, food); 2) employment rate (labour force participation); 3) population structure (population density; % of population living in urban areas); 4) technology (gross domestic product (GDP) per capita and GDP per unit of energy).

This paper examines particularly macroeconomic variables on mortality of ageing people

Mortality=*f*(Inflation, Unemployment, Poverty, GDP per capita, Exchange rate)

$$Mortality_{60}+= \alpha I^{\beta}_1 U^{\beta}_2 GDP^{\beta}_3 E^{\beta}_4 \quad (2)$$

$$\ln M = \omega + \beta_1 I + \beta_2 U + \beta_3 GDP + \beta_4 E \quad (3)$$

where $M_{60}+$ represents mortality at older ages (60+); I being inflation; U stands for unemployment; GDP signifies gross domestic product per capita; E symbolizes annual exchange rate and ω symbolizes lnα

$$Mortality_{75}+ = \alpha E^{\beta}_{1} \quad (4)$$

$$\ln M = \omega + \beta_4 E \quad (5)$$

Where $M_{75}+$ represents mortality at older ages (75+), E symbolizes annual exchange rate and ω symbolizes ln α Methods and measures.

Methods and Data Management

The current work is a secondary data analysis. Data were collected from Jamaica Government Publications, namely Jamaica Survey of Living Conditions (JSLC) [25,26], Economic and Social Survey of Jamaica (ESSJ) [27], Bank of Jamaica [28], Demographic statistics [29] and International Monetary Fund [30]. Jamaica Survey of Living Conditions (JSLC) (Planning Institute of Jamaica and Statistical Institute of Jamaica, 1989-2010) provided data on health care utilization (or health care seeking behaviour), illness rate and poverty; Economic and Social Survey of Jamaica on poverty (Planning Institute of Jamaica, 1989-2009); Statistical Digest on inflation and annual exchange rate (Bank of Jamaica, 1981-2010) and the Demographic Statistics on mortality, crude death rate (Statistical Institute of Jamaica, 1988-2010) and gross domestic product for the publication of the International Monetary Fund. The period for this work is from 1989 to 2009.

The JSLC is jointly conducted by the Planning Institute of Jamaica (PIOJ) and the Statistical Institute of Jamaica (STATIN). The JSLC is a nationally representative cross-sectional descriptive survey which uses stratified random sampling and comprised data on households' characteristics, health, education, expenditure, social programmes, and other information. An administered questionnaire modelled from the World Bank's Living Standards Measurement Study (LSMS) household survey [31] is used to collect the data. There are some modifications to the LSMS, as JSLC is more focused on policy impacts.

The JSLC used a two-stage stratified random sampling design where there was a Primary Sampling Unit (PSU) and a selection of dwellings from the primary units. The PSU is an Enumeration District (ED) which constituted of a minimum of 100 dwellings in rural areas and 150 in urban areas. An ED is an independent geographic unit that shares a common boundary. This means that the country was grouped into strata of Equal size based on Dwellings (EDs). Based on the JSLC, the PSUs is a listing of all the dwellings and this was used as the sampling frame from which a Master Sample of dwelling was compiled. According to the JSLC, the sample was weighted to reflect the population of the nation. The households in the JSLC were interviewed during three to four years, after which a new representative sample was drawn. In this study, we used aggregate to the parish level, which means that analysis can be made across periods (or over time).

The Economic and Social Survey of Jamaica (ESSJ) is a publication of the PIOJ which collates information on social and economic indicators of Jamaica. We collected data mainly on unemployment rate in Jamaica from 1989 to 2009 (Planning Institute of Jamaica, 1988-2010).

The annual exchange rate of the Jamaican to the United States' dollar were collected from the Bank of Jamaica's (BoJ) publication (Bank of Jamaica, 1980-2009) and the Gross Domestic Product (GDP) information was had from the International Monetary Fund's World Economic Outlook (International Monetary Fund , 2009). Data on murder were obtained from Statistical Unit.

Some abbreviations will be used throughout this work. They are CDR- crude death rate; HI-health insurance coverage, HSB-health seeking behaviour (or health care utilization) and GDP (gross domestic product) per capita growth, GDP.

Statistical Analyses

Data were entered and stored into Microsoft Excel and SPSS for Window version 21.0 (SPSS Inc; Chicago, IL, USA) which were both used to analyze the data. Pearson's product Moment Correlation was used to assess the bivariate correlation between particular macroeconomic and other variables. Scatter diagrams and best fit models were used on the data. Ordinary Least Square (OLS) regression analyses were used to establish the model for 1) log mortality and 2) log murder. Ordinary least square regressions were utilized to analyze the possible explanatory variables. A p-value of 5% was chosen to indicate statistical significance. The variables that were entered into the model were significant in the bivariate correlation (Pearson's Product Moment Correlation). In any instance where collinearity existed ($r>0.7$); the variables were entered independently into the model to determine as to which of those should be retained during the final model construction. The final decision on whether or not to retain the variables was based on the variables' contribution to the predictive power of the model and its goodness of fit. Each scatter plot was modelled by a linear, power, exponential or polynomial best fit function based on the data, with the aid of SPSSas well as in Excel.

Natural logarithm was used to normalize variables that were skewed for the purpose of usage in OLS-mortality, inflation, poverty, annual exchange rate, and unemployment. This was also in keeping with the theoretical framework.

Conceptual Definitions

The exchange rate (or Jamaican exchange rate) is the number of Jamaican dollars needed to purchase one United States' dollar (US$1).

Murder denotes the number of people unlawfully killed (a crime causing death without a lawful excuse) within a particular geopolitical zone (excluding police killings or homicides).

Mortality means the total number of deaths occurred within the population for a particular period, which is usually at the year. The quality of mortality statistics in Jamaica is relative good as a study conducted by McCaw-Binns et al. [32,33] found that in 1997, the completeness of registration of mortality was 84.8%; in 1998 it was 89.6%. The quality of completeness of mortality registration has been established by the World Health Organization, ICD classification [34]. A completeness of 70-90% is considered to be medium quality and more than 90% is high quality data. Within the context of the WHO's classification, death statistics in Jamaica is of medium quality and is relatively close to being of high quality. In keeping with the completeness of mortality data in Jamaica, the Statistical Institute of Jamaica [29] has adjusted the data to reflect the 100 completeness of mortality figures.

Plague is a zoonotic disease circulating mainly among small animals and their fleas, and if left untreated can have a case-fatality rate of 30-60 percentage points.

Death is the absence of life or the permanent departure of life after birth.

Mortality of elderly 60+ (or Elderly 60+ mortality) is the total number of annual deaths of those 60+ years old divided by total annual deaths for the population.

Mortality of elderly 75+ (or Elderly 75+ mortality) is the total number of annual deaths of those 75+ years old divided by total annual deaths for the population.

Findings

Table 1 presents mortality data for people 60+ years old, by gender and total elderly mortality rates from 2000 to 2009. Over the last decade of 2000s, elderly death rates lie between 45 and 65 percentage points. In 2009 (latest data available), 59 percentage points of all mortality were accounted for people aged 60+ years old. However, between 2001 and 2009, aged people constituted more than 60 percentage points of total deaths in Jamaica. Between 3 out of every 5 and 4 out of every 5 deaths occurred among elderly were of those aged 75+ years old. Although annually more men than women die in Jamaica, at older ages (60+ years) mortality is a female phenomenon. The rate of mortality of Jamaicans 60+ years old has been relatively stable between 2001 and 2010. Furthermore, between 36 and 47 percentage points of all deaths occurring annual are people 75+ years-mortality of elderly people 75+ years in relations to total annual deaths.

Figure 1 displays the annual percentage point change in mortality at older ages disaggregating by 60+ years, 60-74 years and 75+ years. The greatest percentage point movement in mortality at older ages occurred in 2002 over 2001, with there being moderate changes between 2002 and 2009.

Figure 2 presents a diagrammatic display of intercorrelation among the macroeconomic variables, and the relationship between particular macroeconomic variables and mortality of elderly 60+ years old. Poverty does not directly influence mortality; but it interfaces with unemployment, exchange rate and these factors are associated with mortality.

Of the four (4) variables that were used to examine influence on immortality of elderly people, three emerged as statistical significant factors- 1) lnunemployment (P=0.021; 95%CI: 0.067-0.724); 2) ln exchange rate (P<0.0001; 95%CI: 0.123-0.308), 3) GDP per capita (P=0.028; 95%CI: 0.003-0.050). The factors account for 53.1 percentage points of the variability in lnmortality of aged people (Table 2). The highlighted variables indicate those that are factors of mortality. Unemployment is positively correlated with elderly mortality, which is also the case for the annual exchange rate and GDP per capita.

Results from the forward stepwise regression model revealed the contribution of each factor to the overall model (elderly mortality=f (exchange rate, unemployment, GDP per capita, ε). The exchange rate contributed the most to mortality changes (R^2=29 percentage points) compared to unemployment (R^2=17.6 percentage points) and GDP per capita (R^2=13.7 percentage points).

The moderate statistical correlation between poverty and elderly mortality (r_{xy}=-0.542, P=0.006) is a spurious one as it disappears with the introduction of exchange rate. A strong bivariate relationship exists between lnpoverty and log annual exchange rate (r_{xy}=-0.774, P<0.0001) and a moderate one between log poverty and log inflation (r_{xy}=0.677, P<0.0001).

Table 3 shows information on the macroeconomic variables, the one which emerged as influencing mortality at aged 75+ years. Of the four variables entered into the model, only annual exchange rate was statistically correlated with mortality at 75+ years old.

Discussion

The seminal work of Eldemire-Shearer (former Eldemire) [35] on ageing has resulted in thrust of studies in the area, especially in the Caribbean region [36-41]. Although the study of ageing began before the 1990s by Institutions like the Pan American health Organization [42] and Grell [43] in the late 1980s to early 1990s (1991), it was not until Eldemire dissertation in 1993 and subsequent studies by her that lead to the current body of works on ageing. Like Eldemire, Bogue [21] believed that ageing (60+) is a period of transition of various issues-biological and otherwise- and how these change in degree with process from young-old (60-74 years), aged (75-84 years) to oldest-old (85+ years). Bogues opined that particular issues (health problems, physical disability, demand for medical care, demand for public service, demands on children, dependency, and social isolation) increased

Year	1989	1990	1991	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
60-64	785	801	754	562	561	528	505	558	539	573	567	531	529	514	531
65-69				836	834	785	752	703	685	651	658	616	630	727	751
70-74	1494	1527	1445	1018	1016	956	916	942	862	934	975	913	816	844	871
75+	2743	2677	2652	3358	3349	3151	3020	3185	3267	3158	3379	3163	3052	3242	3348
Men 60+	4237	4204	4097	4376	4365	4107	3936	5388	5353	5316	5579	5223	5027	5327	5501
60-64	716	661	687	473	437	403	378	406	415	403	415	384	386	349	360
65-69				562	520	479	450	539	497	543	501	463	546	439	453
70-74	1175	1234	1158	767	709	654	613	764	701	690	727	671	678	622	642
75+	3294	3253	3219	3740	3458	3188	2990	3595	3749	3753	4061	3750	3931	3716	3337
Women 60+	4469	4487	4377	4507	4167	3842	3603	5304	5362	5389	5704	5268	5541	5126	4792
Total 60+	8706	8691	8474	8883	8532	7949	7539	10692	10715	10705	11283	10491	10568	10453	10293
Total 75+	6037	5930	5871	7098	6807	6339	6010	6780	7016	6911	7440	6913	6983	6958	6685
Male	6530	6613	6252	9126	9008	8506	8149	9234	9045	9210	9473	8917	9137	9581	9893
Female	6489	6552	6275	7915	7285	6832	6324	7784	7654	7695	8079	7400	7911	7419	7660
Population	13019	13165	13319	16197	17447	16338	16204	17018	16699	16905	17552	16317	17048	17000	17553
*Rate 60+	66.87	66.02	63.62	54.84	48.90	48.65	46.53	62.83	64.17	63.32	64.28	64.29	61.99	61.49	58.64
**Rate 75+	46.37	45.04	44.80	43.82	39.02	38.80	37.80	39.84	42.01	40.88	42.39	42.37	40.96	40.93	38.08
***Rate	69.34	68.23	69.28	79.91	79.78	78.75	79.72	63.41	65.48	64.56	64.94	65.89	66.08	66.56	64.95

*Elderly (60+ years old) mortality is calculated by Paul Andrew Bourne from available data.
**Elderly (75+ years old) mortality is calculated by Paul Andrew Bourne from available data.
***Mortality of elderly 75+ years old as ratio of elderly mortality computed by Paul Andrew Bourne from available data

Table 1: Mortality of people 60+ years, 75+ years and population by aged and sex cohorts, and rates of mortality.

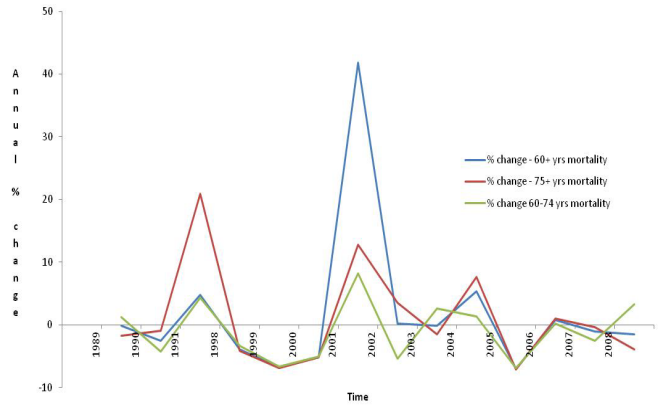

Figure 1: Annual percentage point change in mortality of elderly 60+ year, 1990-2008.

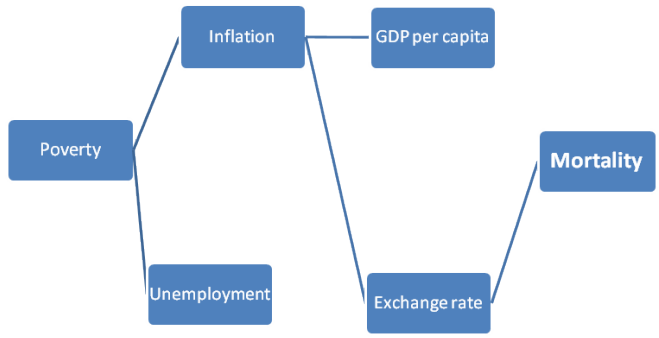

Figure 2: The Macroeconomic Indicators of Mortality Model at Older Ages.

from a low level at young-old to high intensity at oldest-old [21]. Those matters suggest that mortality rises with ageing as well as economics. It is well established empirical that there is a direct correlation between gross domestic product and self-reported illness rate [44]; but the irony is the aged received increasingly less income owing to retirement and this becomes greater in later years of the aged, which highlights the challenges of ageing on the population, social institutions and on family. Another challenge which must be brought into the health discourse is the macroeconomic environment on mortality for the aged, as evidence shows the rise in the elderly population come 2015 and beyond [45].

Overall mortality is a male phenomenon in Jamaica, with the reverse being true at older ages. Jamaicans experience is typical as aaccording to Draper and coauthors, "In 1998-2000, life expectancy at birth for Australian males and females was 76.6 and 82.0 years respectively. Between 1990 and 2000, life expectancy increased by about 2.7 years for males at birth, and by 1.9 years for females. During the same period, the sex difference in life expectancy narrowed: in 1990 a new-born girl could expect to live 6.2 years longer than a new-born boy, and by 2000 this difference had reduced to 5.4 years" [46]. Unlike Draper et al.'s work, this study was primarily concerned with elderly mortality and what are some the factors which influence this phenomenon. Although Sommers' used 65+ years to examine elderly compared to 60+ years for this study, both works can be compared and contrasted to provide an understanding of mortality at older ages. Sommers found that "Individuals age 65 and older have experienced remarkable declines in mortality during the past 20 years. In 1980, 14.2% of newborns could expect to live to age 90; by 2003, this percentage increased nearly 50% to 20.9.Average life expectancy went from 73.7 years in 1980 to 77.8 years in 2004 - about 30.5 years longer than the anticipated life expectancy for a baby born at the beginning of the 20thcentury" [47], which was not the case for this work. The mortality rates for elderly (60+ or 75+ years) in Jamaica for the last 15 years have been relatively stable, with between 60 to 80 percentage points of deaths being among the older elderly (75+ years old). Enveloped in this finding is the vulnerability and frailty of elderly 75+ years in Jamaica, which is equally the same in other geo-political areas [48]. Not only did Andrew and co-authors establish increased frailty and mortality at older ages [48], they argued about the social vulnerability.

The current work identified that positive correlation between 1) poverty and unemployment and 2) poverty and inflation. With increased job separation likely at older ages, this result in a lowering of income and a rise in the likelihood of poverty at older ages in periods of higher inflation, recession and increased health care cost owing to greater demand of health care services. Although inflation is not directly correlated with elderly mortality and there exists a spurious relationship between poverty and mortality at older ages, there are clear indications that particular macroeconomic conditions are interrelating with morality at older ages in Jamaica. Using data some countries in Central America and South-East Asia, Zheng et al. [25] negative correlations between mortality at older ages and 1) employment, 2) population structure, 3) technology (including GDP per capita) and 4) water pollution. While in Central America and some South-East Asian nations GDP is good for lowering mortality, increased GDP per capita in Jamaica is associated with a rise in mortality at older ages. Job separation which is captured in unemployment is a bad for the health of those 60+ years old as unemployment is directly associated with morality, suggesting that social isolation, job separation, lowered income and psychological issues relation to unemployment are affecting the quality of life of elderly people. Because at older ages, particularly 75+ years, are associated with job separation (unemployment), increased frailty, greater risk of health conditions and higher health care utilization, ageing has a greater probability of increased social and societal care for the elderly.

The positive correlation which exists between the annual exchange rate and mortality at older ages has some justifications. An increase in the value of the United States Dollar (USD) - a deterioration of the Jamaican dollars- translates into higher cost of living, medication and economic challenge for those 60+ years, particularly among those 1) unemployment, 2) physically incapable of movement, 3) high demand for health care service and medication and 4) 75+ years old. With the greater likelihood of health conditions at older ages, especially at 75+ years [21], high cost of living will increased the vulnerability of the aged, and result in mortality (pre-mature death). In the same token, the elderly demand greater social amenities and services and therefore with increased unemployment, people are less likely to aid the aged and this accounts for a rise in mortality as the higher cost of living coupled with the unemployment will deplete the resource base of the elderly as well as the society's ability to respond to their demands. The exchange rate which affects the cost of living in Jamaica, especially medication and health care resources translate into economic bad for elderly people. This finding is applicable to all developing nations and provides a rationale for an argument of social intervention and programmes for the elderly in periods of high cost of living.

This is a paradox which arises in the current work as 1) high cost of living is associated with increased mortality at older ages, yet 2) GDP per capita is positively correlated with mortality. In Zheng and co-

Characteristic	Unstandardized Coefficients	Std. Error	Beta	t statistic	*Prob*	95% CI	R^2 contribution
Constant	7.309	0.508		14.379	0.000	6.231 - 8.387	
lnunemployment	0.395	0.155	0.578	2.549	0.021	0.067 - 0.724	0.176
lninflation	0.030	0.031	0.176	0.962	0.350	-0.036 - 0.097	
lnexchange rate	0.216	0.044	1.319	4.930	0.000	0.123 - 0.308	0.290
GDP	0.027	0.011	0.455	2.423	0.028	0.003 - 0.050	0.137
R^2=0.625							
Adjusted R^2=0.531							
F statistic [4,16]=6.669, *Prob*=0.002							
Durbin-Watson=1.9							
N=21							

Dependent variable: lnmortality

Table 2: OLS of selected macroeconomic variables and ln mortality of elderly people (60+ years).

Characteristic	Unstandardized Coefficients	Std. Error	Beta	t statistic	Prob	95% CI
Constant	8.505	0.285		29.856	0.000	7.902 - 9.109
lnunemployment	0.009	0.006	0.285	1.500	0.153	-0.004 - 0.022
lninflation	0.010	0.087	0.027	0.120	0.906	-0.174 - 0.195
lnexchange rate	-0.011	0.018	-0.117	-0.633	0.536	-0.048 - 0.026
GDP	0.078	0.025	0.863	3.193	0.006	0.026 - 0.130
R^2=0.617						
Adjusted R^2=0.522						
F statistic [4,16]=6.457, *Prob*=0.003						
Durbin-Watson=1.7						
N=21						

Dependent Variable: lnMortlaity 75+

Table 3: OLS of selected macroeconomic variables and ln mortality of elderly people (75+ years).

authors' work, GDP per capita was inversely related with mortality at older ages which would indicate that increased income will rise in less mortality and vice versa. Unlike what obtains in Central America and South-East Asian nations [25], increased income is an economic bad for health and result in a rise in mortality among the elderly. Health is a complex phenomenon in Jamaica, especially for the elderly, as the exchange rate is inversely related to unemployment; unemployment is positively associated with mortality among people 60+ years; the exchange rate is negatively correlated with GDP per capita; GDP per capita is directly influencing mortality, and exchange rate positively relate to mortality at older ages. There is a clear difficulty for policy makers to whole salely change one macroeconomic variable in wanting to lower mortality among the elderly.

A critical finding which emerged in this paper is at older ages (75+ years), of the macroeconomic variables used only the exchange rate influenced mortality. The economics of death, therefore, changes with ageing. The mortality of people 75+ years is not affected by GDP per capita, job separation (or unemployment), and inflation. The health phenomenon of aged people cannot be examined across the cohort (60+ years) to provide a comprehensive understanding of these people health status as the macroeconomic climate in the society affects those 75+ years somewhat differently from those 60+ years. As unemployment (job separation) is not a factor influencing the health status of elderly 75+ years compared to those at younger ages (60-74 years old). On the other hand, the extent with which the exchange rate affects those at older (60-74 years) and older ages (75+) is different; and the deterioration in the Jamaican dollar compared to the USD is more intense on the health status (mortality) of those at older compared to those 60-74 years old. The rationale for this is simple cost of health care, survivability and insufficient money owing to retirement.

Although the government of Jamaican introduced the 'Jamaica Drug for the Elderly Programme (JADEP)' in 1996 to lower the cost of some prescription drugs [49], the costs for the others and general rise in the price of those on JADEP list within the context of lowered income and a depletion of savings owing to job separation are result in deaths of this age cohort, and some of the mortality will be pre-mature because of inability to critical expenses-food, health care equipment and machines including drugs. The JADEP programme is not significant reduction in the burden of health care cost for the elderly as Eldemire-Shearer opined that many medical practitioners do not prescribed the medication on the JADEP's list [40]. She went on further to state that "A monthly hypertensive prescription [for the elderly] can cost over [Jamaican] $2000 and a bottle of insulin [Jamaican] $750, which is costly for someone without a steady income. JADEP relieves the burden at [Jamaican] $25 for two items (at the time the book was published in 2005, Jamaican $62.50 was being exchanged for USD 1)" [40]. This study now provides a basis for the increased risk factor experienced by the elderly in developing nations when the exchange rate increases, although there is social assistance from the government to address the cost of health care for this age cohort.

With empirical evidence that human cells degenerate in time and the increased probability of illness including multiple health conditions, a devaluation of the local currency will see a rise in morality among the elderly. The elderly in developing nations who have already lost economic and social power coupled with increased cost of medication and other health care equipment owing to deterioration in the country's currency are placed under increasing stress and become increasingly more vulnerable to mortality. Many developing nations purchase pharmaceutical products from the developed nations which make the exchange rate a critical component in the health care deliveries and the health of populous, even more so for the vulnerable groups like the elderly, poor, poor elderly, unemployed elderly and unemployed poor elderly. There is an economic burden on the health of the elderly,

particularly among those with chronic non-communicable diseases [50,51] as they seek to improve their health, wellbeing [52] and delay mortality.

Conclusion

The health status elderly measured using mortality while is not an accurate assessment of present conditions of people is a good evaluation of objective health. This objective assessment of health is influenced by particular macroeconomic conditions within a society. Overall, mortality of aged people 60+ years is affected by 1) annual exchange rate, 2) unemployment, and 3) Gross Domestic Product (GDP). Different macroeconomic factors influence mortality at older years, particularly 60+ and 75+ years, at a different rate. The annual exchange rate in Jamaica is the most dominant factor influencing mortality at older ages, moreso for those 75+ years old. In the same token, unemployment and GDP do not impact the mortality for those 75+ years although they influence it at younger ages (60-74 years old). The opportunity cost of increased exchange rate of the Jamaican and USD is the rise in mortality at older age (60+ years), particularly for those 75+ years. It follows that there is intercorrelation between death at older ages and economics, and there is a differential based on the age cohort (60-74 and 75+ years). The economic vulnerability of elderly people is made worse by the economic climate, and while job separation does not affect the health status of those 75+ years, its plays a role in bad health of those 60-74 years old. The exchange rate of the Jamaican and USD can be a retardation in good healthstatus of older people because it influences cost of medication, cost of critical health equipment and machines which are demanded by the elderly as well as cost of many health care services and basic foods.

In summary, the study of gerontology, public health, health crimes, epidemiology and demography is now required to include macroeconomic variables in their discourse as there is empirical evidence to support the influence of these factors on the objective health of elderly. Policy administrators and specialists must be equally cognizant of the impact of the macroeconomic climate on health of the aged, moreso the exchange rate in health care planning particularly for elderly 75+ years. The opportunity cost of mortality among elderly 60+ years is expressed in movements of the exchange rate, unemployment and GDP per capita, offering a rationale for the inclusion of these issues in public health management and care of the elderly. Social programmes and intervention, therefore, must be planned in keeping with changes in unemployment rate, GDP and exchange rate for the elderly as they will become more vulnerable to deterioration in the economic, particularly those 75+ years.

Conflict of Interest

The authors have no conflict of interest to report at this time.

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