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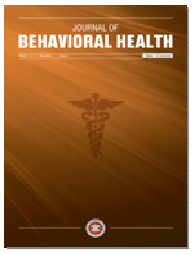

Original Research

Under-five mortality, health and selected macroeconomic variables: The children behind the digits

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Abstract

Background: The literature is filled with studies that have evaluated infant mortality, child mortality, and income distribution and mortality, but no single research in the English-speaking Caribbean has wholly examined the relationship among child mortality, inflation, infant mortality, poverty, and economic crisis as well as modeling those phenomena.
Objectives: This work seeks to bridge the gap in the literature by modeling child mortality, inflation, infant mortality, poverty, and economic crisis as well as the appropriateness of linear modeling in addition to an assessment of under-five age-specific mortality.
Methods: This work uses data collected from various Jamaican government departments' publications. Data were entered, stored and analyzed using the Statistical Packages for the Social Sciences (SPSS) for Windows version 17.0 (SPSS Inc; Chicago, IL, USA) as well as Microsoft Excel. Pearson's product Moment Correlation was used to assess the bivariate correlation between particular macroeconomic variables and other variables, and Ordinary least square regression analyses were used to establish the model for 1) log Infant mortality rate; and 2) log child mortality rate.
Results: Poverty, inflation, unemployment and gross domestic product influence child mortality. The findings revealed that there is an inverse correlated between health care utilization and infant mortality rates, and unemployment negatively influences child deaths. During economic recession infant and child mortality rates decline and the opposite is true in periods of economic growth.
Conclusion: This work provides a basis for public health actions and programmes to stem the incidence of child mortality particularly in periods of economic downturn and rise in cost of living.

INTRODUCTION

The study of mortality dates back to the seventeenth century [1-3]. John Graunt's work on the 'Bill of mortality' [1] sets a premise for the establishment of mathematical modeling in the area of mortality. In the nineteenth century, Gompertz developed a mathematical formula that estimated mortality at different ages [4]. Gompertz's theory established that mortality increases at geometric progression at a particular age and forwarded that this can be represented by a mortality risk function $\mu(x) = \alpha . e^{\beta x}$. It follows that log of the death rate (ln [μ(x)]) is a linear function of age - $\ln [\mu(x)] = \ln (\alpha) + \beta x$. Gompertz's theory underlines purging mortality of accidental or infectious causes [5]. He believed that those causes act independently of age, which explained Makeham's suggestion of including a constant to address the limitation of Gompertz's law- $\mu(x) = \alpha . e^{\beta} + \gamma$ [6]. Although later studies have rebuffed Gompertz or Makeham's function that it does not hold true at older ages and that it overly estimated mortality at older ages (80+ years) [7,8], the work has laid the foundation upon which many studies have been framed [9]. The life tables is one of the creations that emerged from mortality statistics [10, 11], which was used to indicate life expectancy or the health of a population.

The literature speaks to decreasing mortality at younger ages, Bourgeois-Pichat [12,13] proposed disaggregating infant mortality in endogenous and exogenous (accidents or infections) components and fitted this by the formula: $q(n) = a + b[\ln(n + 1)]^3$, where *a* is a constant denoting the endogenous process, cumulative death in the cohort by age n (in days). Modifications are well documented in the literature to Bourgeois-Pichat's work [14], which guides contemporary studies in the area. Examining child health using infant and child mortality rates in Peru, Paxson and Schady [15] found that infant mortality increased during economic crisis and that infant and child mortality followed a co-linear pattern over the studied period (1978 to 1999). Paxson and Schady [15], like early scholars fitted infant mortality rates with linear models for each year of birth: $M_{it} = \alpha + X_{it}\beta it + \varepsilon_{it}$, where M_{it} is child born in year *t* to mother *i* died in the first year of life; X_{it} is maternal characteristics (level of schooling, age, area of residence) and the error term, ε_{it}.

The earlier pioneers are still guiding the directions of contemporary scholars. In 1992, Robert Waldmann [16] in assessing infant mortality and income, used log (infant mortality) = β log (Nonrich Income) + γRich Share. He modified the early model as follows: log (infant mortality) = $\beta_0 + \beta_1$ log (Poor Income) + $\beta_2$log (Middle Income) + γRich Share + δYear 1970. Using the aforementioned model, Waldmann found a positive correlation between log (Poor income) and log infant mortality and a negative one for log middle income and log infant mortality.

There is documentary evidence of the effect of income, economic crisis and other socioeconomic conditions on infant mortality, (that is, maternal selection, age, education of mothers, area of residence, health care utilization, household consumption and crime) [15, 16]; Paxson and Shady [15] spoke about the quality of data on infant mortality in Peru. The quality of data on infant mortality, affects not only the analysis, it also creates a distorted outcome of reality from faulty data. The World Health Organization's (WHO) ICD classification on data indicated that a completeness of 70-90% denotes medium quality data [17], this is also the case for Jamaica [18, 19]. In 2010, the Statistical Institute of Jamaica [20] opined that 4 out of every 5 infant deaths were estimated to be in the year the child was born and that the remaining deaths were those born in the previous year. The quality of infant mortality data in Jamaica is relatively reliable unlike the data obtained in Peru [15].

The literature has provided empirical evidence that infant mortality data for Jamaica can be used to compare with those of other nations, and by extension birth and death statistics [20]. It is also documented that infant mortality is inversely related to economic recession in the United States [21-23]. The studies on infant mortality in Jamaica have not been examined using different explanatory variables such as recession, maternal selection, age, education of mothers, area of residence, health care utilization, household consumption, and crime [18, 19, 24-26], which provides no basis for comparison of the findings. In 1992, the United Nations conducted a study on child mortality in developing nations (including Jamaica [27]), which provided a comprehensive assessment among many nations. Like other studies on Jamaica, many of the identified variables were not examined in the United Nations' work. However, using illness rate, child diarrhoea and body mass index, Kim and Serra-Garcia [28] found that in Jamaica, illness and child diarrhoea rates increased during economic downturns.

The data is available on infant mortality in Jamaica, yet no study is forthcoming on infant mortality relating to inflation, poverty, health care use, child mortality, gross domestic product (GDP) per capita growth, or the economic crisis. There is no empirical work that has examined in a single study the aforementioned variables, as well as evaluates linearity or collinearity of: 1) infant mortality; 2) child mortality; 3) inflation and infant mortality or child mortality rates; 4) health care utilization and infant mortality or child mortality rates; 5) poverty and infant mortality or child mortality rates; 6) age-specific mortality rates of children < 5 years old; 7) illness rate and infant or child mortality rates; 8) infant and child mortality rates; and 9) shifts in trends of infant and child morality. The present paper bridges the gap in the literature by examining all the previous mentioned issues, using data from 1988 to 2009 and from 1900 to 2000.

METHODS

Empirical Model

The model used to determine factors which account for infant mortality rates and child mortality rates is embodied in Robert Waldmann's theory. Waldmann theorized that

log (infant mortality) = $\beta_0 + \beta_1$ log (Poor Income) + $\beta_2$log(Middle Income) + γRich Share + δYear 1970.

For this research:- log infant mortality (IMR) was expressed in equation [1]; log child under 5 mortality rate (CMR) was modeled in equation [2]; and log illness rate in equation [3]:

Log IMR = $\beta_0 + \beta_1$GDP per capita growth + β_2HSB + U_i ……...[1]

Log CMR = $\beta_0 + \beta_1$ln (poverty) + $\beta_2$ln (Unemployment rate) + β_3GDP per capita growth + β_4 (Illness rate) + U_i ……..…[2]

Ln Illness rate = $\beta_0 + \beta_1$ln (poverty) + $\beta_2$ln (Unemployment rate) + β_3GDP per capita growth + U_i .....[3]

Where health seeking behavior (or health care utilization, HSB), β_0 is the constant and $\beta_{1\text{-}2}$ are coefficients of factor, and U_i represents the error term.

Using 20-year data from 1900-2010, equations [4.1, 4.2] and [5.1, 5.2] model different under-five mortalities.

$IMR = \alpha x^{\beta}$ …… [4.1]

It can be deduced from equation [4.1] that by natural logging both sides of the equation would give:

$Ln\ IMR = \ln(\alpha) + \beta \ln x$ …… [4.2]

$CMR = \alpha x^{\beta}$ …… [5.1]

From equation [5.1], we deduced:

$\ln CMR = \ln(\alpha) + \beta \ln x$ …… [5.2]

where β has negative values

Using 5-year data from 1960-2005, IMR was modelled within the context of the data – Equation [6]:

$CMR = ax^2 + bx + c$ …… [6]

Where is c is a constant, 'a' and 'b' represent coefficients of x, and x being time interval.

Using annual data from 1989-2009, IMR and CMR were modelled which are expressed in Equations [7] and [8]:

$IMR = ax + c$ …… [7]

$CMR = ax + c$ …… [8]

Whereas 'c' is a constant, 'a' represents coefficients of x, and 'x' being time interval.

Data source and management

The current work is an analysis of collated secondary data from various Jamaican Government Publications. Data were taken from: Jamaica Survey of Living Conditions (JSLC) [29] regarding health care utilization (or health care seeking behaviour), illness rate and poverty; Economic and Social Survey of Jamaica on poverty [30]; and the Statistical Digest on inflation [31]. The period for this work is from 1989 to 2009 and 1900 to 2000.

The JSLC is jointly conducted by the Planning Institute of Jamaica (PIOJ) and the Statistical Institute of Jamaica (STATIN) [29]. The JSLC is a nationally representative, cross-sectional, descriptive survey, drawn using stratified random sampling and comprised data on households' characteristics, health, education, expenditure, social programmes, and other information. An administered questionnaire was used to collect the data, and it was modelled from the World Bank's Living Standards Measurement Study (LSMS) household survey [32]. There are some modifications to the LSMS, as JSLC is more focused on policy impacts.

The Economic and Social Survey of Jamaica (ESSJ) is a publication which collates information on social and economic indicators in Jamaica. It is published by the Planning Institute of Jamaica. Data were collected mainly on unemployment rates in Jamaica from 1989 to 2009 [30].

Annual inflation rates for Jamaica were collected from the Bank of Jamaica's (BoJ's) monthly publication [31] and the Gross Domestic Product (GDP) information was taken from the International Monetary Fund's World Economic Outlook [33].

The macroeconomic variables (inflation, poverty, unemployment and GDP) as well as infant and child mortalities were for a 12-month period, ending December of each calendar year.

According to the Statistical Institute of Jamaica, "Under 5 Mortality Rate, … is "The probability that a child born in a specific year or time period will die before reaching the age of five, if subject to current age-specific mortality rates. Expressed as a rate per 1,000 live births [20], which is the used in this paper.

Child mortality rate is the probability of dying between the exact ages of one and five, if subject to current age-specific mortality rates. The probability is expressed as a rate per 1,000.

Infant mortality rate is the number of deaths of infants (less than 12 months old) per 1000 of live births during a given period of time

Illness rate is the percentage of Jamaicans who indicate having an illness in the survey year of the cross-sectional survey [29].

Under-five age-specific mortality rate (ASDR) is the total number of deaths of children under 5 years with respect to total mortality per 1000 (or measures the occurrences of deaths at ages less than 5 years).

Statistical analyses

Data were entered and stored into SPSS for Windows version 17.0 (SPSS Inc; Chicago, IL, USA) as well as Microsoft Excel to analyze the data. Pearson's product Moment Correlation was used to assess the bivariate correlation between particular macroeconomic and other variables such as health care utilization and self-reported illness. Scatter diagrams and best fit models were used on the data. Ordinary least square regression analyses were used to establish the model for: 1) log Infant mortality rate, and 2) log child mortality rate. Ordinary least square regressions were utilized to analyze the possible explanatory variables. A p-value ≤ 5% was chosen to indicate statistical significance. The

final model was based on those variables that were statistically significant ($p \leq 0.05$). In any instance where collinearity existed ($r > 0.7$); the variables were entered independently into the model (Forward Stepwise method) to determine 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 modeled by a linear, power, exponential or polynomial best fit function based on the data, with the aid of Excel. SPSS was used to validate the results of Microsoft Excel.

RESULTS

Figure 1 depicts the infant mortality rate for the past 120 years in Jamaica. The diagram shows that IMR is best fitted by a non-linear curve. Since the 1960s, IMR has been declining at a decreasing rate. IMR has exponentially declined between the early 1900s and late 1960s and beyond.

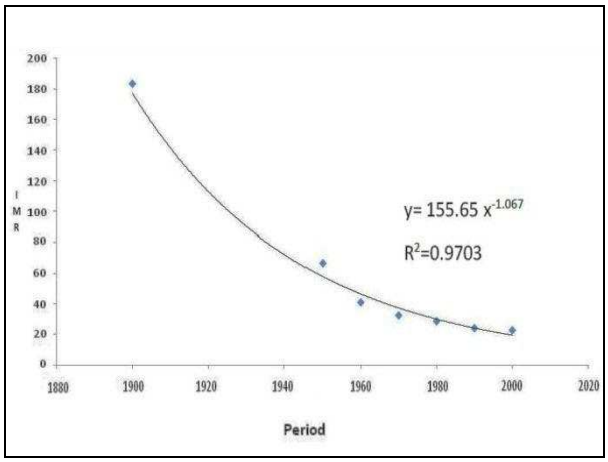

Figure 1. Infant mortality rates (IMR) over 8 periods, 1909 to 2000

Figure 2 illustrates infant mortality rate from 1960 over a 5-year period. The data is best fitted by a 2-degree polynomial function, indicating that the rate of change in IMR is non-linear – decreasing slope (or decreasing rate of change as the years increase).

During the early twentieth century, crude death rates in Jamaica had been declining at an increasing rate, and then after 1950s, the rate was reducing at a decreasing rate (Figure 3).

The rate of change for IMR for 1989 to 2009 on average has been declining at an arithmetic progressive rate (Figure 4).

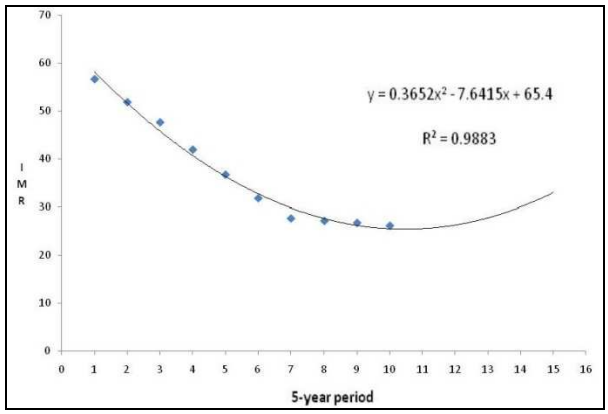

Figure 2. Infant mortality rates (IMR) for 5-year periods, 1960, 1965, ..2005

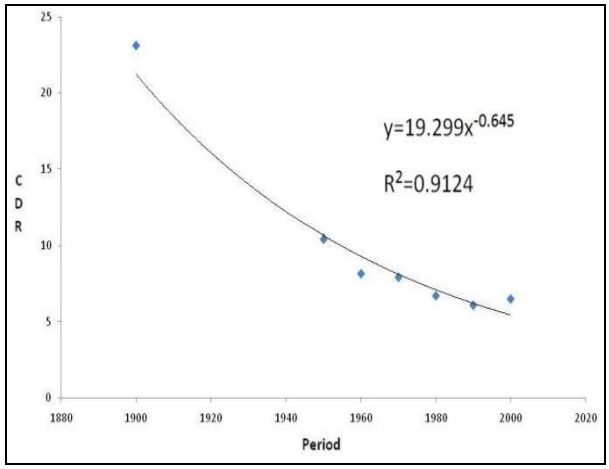

Figure 3. Crude death rates (CDR) and 8 periods, 1990-1909 to 2000-2009.

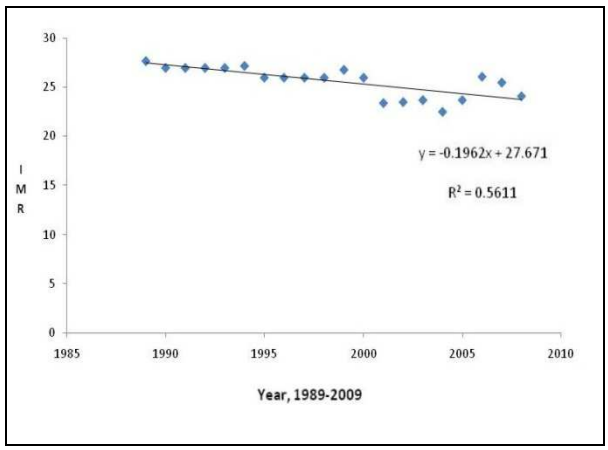

Figure 4. Infant mortality rates (per 1000 live births) from 1989-to-2009.

Since 1989, CMR in Jamaica has been decreasing on average by an arithmetic rate (Figure 5).

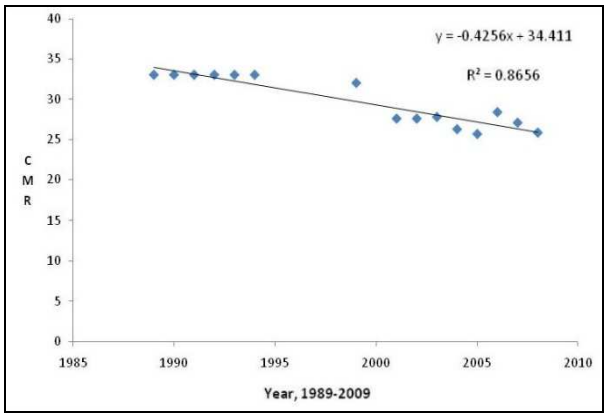

Figure 5. Child mortality rates (per 1000 live births) from 1989-to-2009.

Figure 6 depicts age-specific death rate (ASDR) of children under 5 years old from 2002 to 2009. There was an unusual decline in ASDR in 2006 when compared to previous years, as well as an increase the years thereafter.

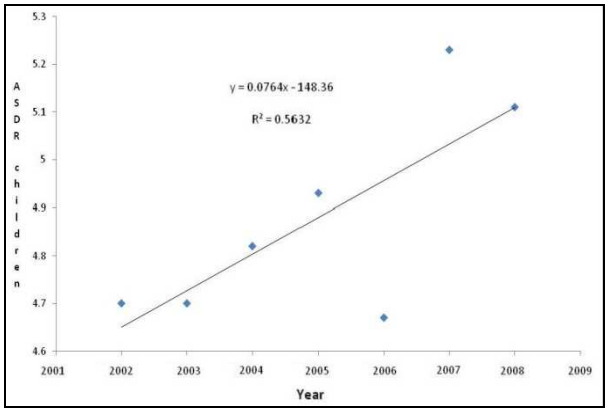

Figure 6. Age-Specific Death Rates (ASDR) of children 0-4 years, 2002-2008

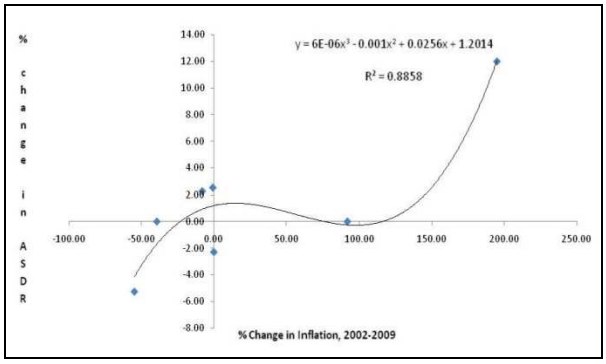

Figure 7: Annual % change in ASDR of children less than 5 years old and annual % change in inflation, 2002-2009

Figure 7 depicts that during decline in inflation rates, ASDR increases, reaches a peak then begins to fall. However, a drastic increase in inflation by over 100% sees an exponential rise in ASDR.

Table 1 displays the correlation of many variables. Strong associations existed between log CMR and log Poverty (r_{xy} = 0.767, P = 0.0001), log IMR and log CMR (r_{xy} = 0.896, P < 0.0001), and health care utilization and log CMR (r_{xy} = - 0.793, P < 0.0001).

Of the variables used, two factors emerged as explaining log infant mortality rate (GDP per capita growth), which accounts for 55% of the variability in log IMR (Table 2)

Log child under 5 mortality rates is accounted for by: log unemployment (p< 0.05), log poverty (P< 0.05), log GDP per capita (P < 0.05), and illness (P= 0.05) (Table 3).

Table 4 presents information on selected macroeconomic variables as well as health care utilization and their influence (or otherwise) on log self-reported illness rate (or ln illness rate). Of the five (5) variables used in the model, three (3) emerged as statistically significant factors – ln poverty (P = 0.028); ln unemployment (P = 0.021), and GDP per capita (P = 0.028). Unemployment and GDP are directly correlated to illness rate, with poverty being inversely associated with illness rate. The three (3) factors account for 60 percentage points of the variance in log illness rate.

DISCUSSION

Kim and Serra-Garcia [28] "found that illness rates and child diarrhea rates increase during economic downturns." Like Kim and Serra-Garcia, this work highlighted that the association between child's health and GDP per capita growth is a mixed one. In the present study, during an economic downturn child morality as well as infant mortality rates declines and these increases in periods of economic growth. This is contrary to the findings in Paxson and Schady [15] that found that infant mortality increased during the crisis of the 1980s in Peru. However, this study's result support those found in the United States [21-23]. Chay and Greenstone [21] and other studies [22,23] opined that the reasons for the decline in infant mortality were owing to maternal behaviour, changes in the composition of women giving birth, and air pollution; this paper is adding reduction in poverty and illness rate.

Macroeconomic variables like poverty, unemployment and GDP per capita growth were found to be correlated with child mortality rates in this study, but only GDP per capita emerged as a factor of infant mortality rates. The illness rate in the Jamaican population is positively

Table 1. Correlation of log CMR, log Poverty, log IMR, log Inflation, health seeking behavior, GDP per capita growth and log unemployment

		HSB	Ln Inflation	Ln Poverty	Ln IMR	Ln CMR	Ln Unempl-oyment	Illness rate
HSB	Pearson Correlation	1	-0.673**	-0.753**	-0.534*	-0.793**	-0.412	-0.494*
	Sig. (2-tailed)		0.001	0.000	0.015	0.000	0.063	0.023
	N	21	21	21	20	15	21	21
Ln Inflation	Pearson Correlation	-0.673**	1	0.677**	0.508*	0.696**	0.350	0.220
	Sig. (2-tailed)	0.001		0.001	0.022	0.004	0.120	0.338
	N	21	21	21	20	15	21	21
Ln Poverty	Pearson Correlation	-0.753**	0.677**	1	0.506*	0.767**	0.473*	0.215
	Sig. (2-tailed)	0.000	0.001		0.023	0.001	0.030	0.350
	N	21	21	21	20	15	21	21
Ln IMR	Pearson Correlation	-0.534*	0.508*	0.506*	1	0.896**	0.111	0.163
	Sig. (2-tailed)	0.015	0.022	0.023		<0.0001	0.640	0.493
	N	20	20	20	20	15	20	20
Ln CMR	Pearson Correlation	-0.793**	0.696**	0.767**	0.896**	1	0.156	0.277
	Sig. (2-tailed)	<0.0001	0.004	0.001	<0.0001		0.578	0.318
	N	15	15	15	15	15	15	15
Ln Unemployment	Pearson Correlation	-0.412	0.350	0.473*	0.111	0.156	1	0.621**
	Sig. (2-tailed)	0.063	0.120	0.030	0.640	0.578		0.003
	N	21	21	21	20	15	21	21
Illness rate	Pearson Correlation	-0.494*	0.220	0.215	0.163	0.277	0.621**	1
	Sig. (2-tailed)	0.023	0.338	0.350	0.493	0.318	0.003	
	N	21	21	21	20	15	21	21

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)
HSB denotes health care seeking behaviour (or health care utilization)

correlated with child mortality rate, which does not influence infant mortality rate. Clearly, when Smith and Kington [34] postulated that money can buy good health could seem like a logical explanation at the time for greater life expectancy in developed nations, particularly in the case of the United States. However, this cannot be used in a wholesale manner to interpret better health status of those with more income. When Michael Marmot [35] examined income and health in developed nations, using the United States, and results refuted the arguments of Smith and Kington when he said that "Richard Wilkinson drew attention to the apparent contradiction, set out above, that when comparing rich countries, there is little relationship between average income and life expectancy, yet within these countries there is a close relationship between individuals' incomes and their life expectancy and mortality" (page 42) and "…the lack of relationship between mean income and a country's life expectancy was because a country's mean income did not convey the same meaning as the relative income level of people within a country" (page 42).

This research concurs with Marmot, as during economic growth, under-5 mortality and infant mortality rates increase and vice versa in periods of economic downturn. It can be concluded herein that this refutes Smith and Kington's argument that money is good for health. Although it provides access to better resources, this does not translate to better health among children in Jamaica. However, there are some merits to Smith and Kington's postulations as in this work there is a strong negative association between poverty and health seeking behaviour, a direct relationship between poverty and unemployment, and unemployment and illness rate. Unemployment which is greater among the poor than the non-poor in many societies is equally influencing the illness rate of the population, and a higher rate of illness is impacted by money, suggesting that the lack of money (or access to it) is detrimental to child health, as was found between inflation and age-specific mortality in this work. With the positive correlation between inflation and poverty in this study, the latter should offer some explanation as to the poverty-illness discourse.

The association between poverty and illness is well documented in the literature. The WHO indicated that four (4) out of every five (5) people with chronic illnesses were in developing countries, and that three (3) of every five (5) global mortalities are caused by chronic illness [36]. This implies that there is an association between poverty and chronic illness, social deprivation and mortality and money and good or bad health [37]. The current work found that the most influential factor influencing illness rate in Jamaica is poverty followed by unemployment and GDP per capita growth. This should not be surprising as lack of

Table 2. Ordinary least square OLS regression on variable that explain (or not) log IMR

Characteristic	B coefficient	Std. Error	beta	*Prob*	CI (95%)
Constant	3.231	0.491		0.000	2.15 - 4.31
HSB	-0.004	0.002	-0.532	0.023	-0.01 - 0.01
Log Inflation	0.018	0.030	0.211	0.562	-0.05 - 0.09
Log Poverty	0.105	0.076	0.583	0.192	-0.06 - 0.27
GDP per capita	-1.960	0.980	-0.508	0.05	-4.12 - 0.20
Log unemployment	-0.224	0.135	-0.499	0.125	-0.52 - 0.07
Illness rate	0.017	0.010	0.609	0.126	-0.01 - 0.04

$R^2 = 0.55$
Adjusted $R^2 = 0.30$
F statistics = 9.396, $P = 0.008$

money retards choices, opportunities, health care utilization and nutritional intake [38-40]. Poverty, which mars opportunities and health care use of women, will influence childbirth, infant and child mortality. The survivability of infant or children under 5 years is dependent on the nutritional intake of the women during childbirth, air pollution (physical environment), health care utilization, finances, educational level, age and poverty of the mother. Such issues provide justifications for worsened health during economic crises [41-44], and that Dollar and Kraay's postulation that growth is good for the health of the poor has some merit [45]. Unlike the literature, the present work found that poverty is inversely related to illness as well as negatively correlated with child mortality rate and not statistically associated with infant mortality rate, suggesting the poverty argument is complex and cannot be used to explain infant mortality rate in Jamaica; but a reduction in demand for health care services. Embedded in the aforementioned findings is the poverty-health paradox which violates the findings from the literature on the direct correlation between poverty and illness, while supporting the inverse relationship between poverty and health care utilization.

The value of Dollar and Kraay's statement is based on: 1) the increased employment, 2) greater income and money, 3) more choices, 4) increased health care utilization, 5) reduced poverty, and 6) greater nutritional intake and quality foods, which all have a role in raising health outcome. A paradox emerges in this work as there is an upward movement in under-five mortality and infant mortality rates during economic expansion, which is not in keeping with Dollar and Kraay's perspective. With particular results arising from economic expansion, it appears ironic that in prosperous times, the health of children will be lower than in economic recession. The positive correlation between increased child or infant mortality and economic growth is not limited to Jamaica, as there is evidence to support this in other jurisdictions [21-23].

Table 3. Ordinary least square OLS of variable that explain (or not) log CMR

Characteristic	B coefficient	Std. Error	beta	*Prob*	CI (95%)
Constant	3.28	0.492		0.001	2.08 - 4.49
HSB	0.00	0.004	-0.71	0.836	-0.01 - 0.01
Log Inflation	0.03	0.029	0.26	0.289	-0.04 - 0.10
Log Poverty	0.22	0.075	0.86	0.028	0.33 - 0.40
Log Unemployment	-0.39	0.126	-0.63	0.022	-0.70 - -0.08
GDP per capita growth	-2.66	0.984	-0.35	0.035	-5.07 - -0.25
Illness rate	0.03	0.012	0.61	0.05	0.00 – 0.06

$R^2 = 0.90$
Adjusted $R^2 = 0.81$
F statistics = 9.396, $P = 0.008$

Dependent variable: log CMR
The statistical significant variables ($P \leq 0.05$) are highlighted in purple

Table 4. Ordinary least square (OLS) regression of selected macroeconomic variables and log illness rate

Characteristic	Unstandardized Coefficients	Std. Error	beta	*Prob*	95% CI
Ln Poverty	-0.337	0.136	-0.624	0.028	-0.632 - -0.042
Ln Unemployment	0.541	0.205	0.514	0.021	0.097 - 0.984
GDP per capita	4.424	1.785	0.412	0.028	0.569 - 8.280
HSB	-0.012	0.007	-0.487	0.105	-0.027 - 0.003
Ln Inflation	0.011	0.069	0.040	0.879	-0.139 - 0.160

R2 = 0.70
Adjusted R2 = 0.60
F statistics = 6.083, P = 0.004

Paxson and Schady [15] found a high elasticity of infant mortality and income (0.64), suggesting that economic expansions supports greater infant mortality rates. The empirical evidence from the literature concurs with the present findings that growth is 'bad' for children's health as well as the general populace.

Under-five mortality and infant mortality rates have been declining at an increasing proportion for 1900 to 1950 (geometric progression) and since the 1960s, the rates have been decreasing at an arithmetic progression. It can be extrapolated from the findings that the introduction and utilization of penicillin – discovery attributable to Scottish scientist and Nobel laureate, Alexander Fleming in 1928 - has made significant changes to the number of deaths of children in the world, so too the industrial and technology revolution. Since the early 1900s at periods of high prevalence and incidence of infectious diseases, the use of penicillin and advancement in public health measures such as sanitation, and improved food and water quality, there was a transition from infectious to degenerate diseases, which accounted for the change in under-5 mortality in Jamaica. There is relative consistency in the decline in infant mortality and child mortality rates in Jamaica which is not the same in Peru [15]. Peru has experienced more volatility in its infant and child mortality from 1978 to 1998, when compared to Jamaica there was seen a constant decline for the same period. Like in many developing nations (Puerto Rico, Philippine, Rwanda, Senegal) [27], infant mortality rates in Jamaica have changed its rate of deceleration from the pre-1970s value to the post-1970s, which was also observed for the United States [46]. It was observed in this work that under-5 mortality is volatile to the macroeconomic conditions that would result in increases in child morality despite the advancement in technology and information, and the effects of public health programmes in lowering deaths among children.

CONCLUSION

The continuous decline in infant and under-five mortality rates in Jamaica speaks to the improvement in overall life expectancy and health of the populace. Despite the improvements in infant and child mortality that have been noted in this research, some of the positives can be eroded with increased poverty and economic expansion, and lowered health care utilization. These findings provide a barometer of children's well-being in Jamaica, the role of particular macroeconomic parameters on their health, and the challenges that must be addressed in economic expansion.

Macroeconomic variables influence (or not) under-5 mortality in different ways and attention must be placed on poverty, inflation, gross domestic product (GDP) and unemployment as these provide public health specialists and policy makers with a comprehensive understanding of the working of those measures on health of children, and how to structure programmes in keeping with their changes. One of the critical findings of this study is the negative correlation between GDP and under-5 mortality, suggesting that in periods of economic recession there will be a rise in infant and child mortality. Within the context of the aforementioned findings, in periods of persistent economic decline public health administrators and practitioners must implement measures that are likely to addressing spiraling under-5 morality because there is a likelihood of pre-mature under-5 mortality. Outside of economic recession, in periods of rise in inflation and poverty, policy makers should also recognize that there will be an increase in infant mortality rates which speak to high probability of pre-mature under-5 mortality arising from lowered health care utilization. Hence, offering free health care services will not be sufficient to reduce under-5 mortality as in periods of economic recession and higher cost of living the

opportunity cost of health care utilization is food and other daily expenses which will take precedence over health care demands except in perceived life threatening situations. The aforementioned argument is reinforced by the fact that in 2007, 83.4% of Jamaican children under 5 years were not covered by a health insurance policy and 63% were brought to health care facilities because of ill-health [47], suggesting that economic recession will result in the depletion of children's health status and the likely consequence can be premature mortality because of economics.

In summary, the precursor to changes in under-5 mortality is the macroeconomic environment within a society can erode the gains of sanitation, water and food quality, the Information Revolution, and medical advancements. The discipline of public health, therefore, must incorporate macroeconomic variables such as inflation and GDP in its management of child health. From the findings of the current work, public health specialist must target young females, poor young females, pregnant young female, young families, and females on the economic margins of society. Another group of interest must be young rural females, who are more likely to be poor, less educated at the tertiary level and at home.

LIMITATIONS

The author did not validate the accuracy of the data source. However, other scholars have examined death data from which modifications have been done. No validations have been carried out on inflation, poverty and unemployment. Over the years poverty calculations have been assessed, reassessed and modified in keeping with new revelations. While the macroeconomic variables (inflation, poverty, unemployment and GDP) and mortality reflect figures for a 12-month period – ending December of each calendar year, self-reported illness and health care utilization are for a 4-week period in the survey year.

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