Under-Five Mortality, Health and Selected Macroeconomic Variables: The Children behind the Digits

Paul A. Bourne

Socio-Medical Research Institute, Kingston, Jamaica, West Indies

Abstract

Background: Mortality is filled with studies that evaluated infant mortality, child mortality, and income distribution and mortality, but no single research in the English-speaking Caribbean has wholly examined child mortality, inflation, infant mortality, poverty and economic crisis as well as modeling those phenomena.

Objectives: This work bridges the gap in the literature by assessing 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 and stored into Statistical Packages for the Social Sciences (SPSS) for Window 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, 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: Infant mortality rate (IMR) over the last 100 years is best fitted by an inverse exponential function ($R^2 = 0.97$) as well as child mortality rate (CMR; $R^2 = 0.91$). Infant mortality rate is influenced by health care utilization ($b = -0.004, 95\% CI: -0.01 – 0.01$) and GDP ($b = -1.960, 95\% CI: -0.52 – 0.07$), and the two factors account for 55% of the variance in IMR. The factors that are correlated with child mortality rate are log poverty ($b = 0.22, 95\% CI: 0.33 – 0.40$) and GDP per capita ($b = -2.66, 95\% CI: -5.07 – -0.25$). Those factors account for 90% of the explanation of changes in CMR. During economic recession IMR and CMR decline and opposite is true in periods of economic growth.

Conclusion: This work provides a basis public health actions and programmes.

Keywords: Child mortality rate; Infant mortality rate; Age-specific death rate; Macroeconomic indicators; Health seeking behaviour; Jamaica

Introduction

The study of mortality dates back to the seventeenth century [1-3]. Graunt’s [1] work on the ‘Bill of mortality’ sets a premise for the establishment of mathematical modeling in the area of mortality. In the nineteenth century, Gompertz [4] developed a mathematical formula that estimated mortality at different ages. Gompertz’s [4] theory established that mortality increases at geometric progression at a particular age and forward that this can be represented by a mortality risk function $\mu(x) = a. e^{b}$. It follows that log of the death rate $\ln(\mu(x))$ is a linear function of age - $\ln(\mu(x)) = \ln (a) + bx$. Gompertz’s [4] theory underlines purging mortality of accidental or infectious causes [5]. He believed that those causes act independently of age, which explained Makeham’s [6] suggestion of including a constant to address the limitation of Gompertz’s [4] law- $\mu(x) = a. e^{b} + y$. Although later studies have rebuffed Gompertz [4] or Makeham’s [6] 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 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 [13] work, which guide contemporary studies in the area. Examining child health, using infant and child mortality rates in Peru, Paxson and Schady [14] found that infant mortality increased during economic crisis and that infant and child mortality followed a collinear pattern over the studied period (1978-1999). Paxson and Schady [14] like early scholar fitted infant mortality rates with linear models for each year of birth: $M_t = a + X_t \beta_t + \epsilon_t$, where $M_t$ is child born in year $t$ to mother I died in the first year of life, $X_t$ is maternal characteristics (level of schooling, age, area of residence) and the error term, $\epsilon_t$.

The earlier pioneers are still guiding the directions of contemporary scholarships. In 1992, Waldmann [15] assessing infant mortality and income, used log (infant mortality) = $\beta_0 + \beta_1 \log$ (Nonrich Income) + $\gamma$ Rich Share. He modified the early model as follows: log (infant mortality) = $\beta_0 + \beta_1 \log$ (Poor Income) + $\beta_2 \log$(Middle Income) + $\gamma$ Rich Share + $\delta$Year 1970. Using the aforementioned model, Waldmann [15] 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 on infant mortality, income, economic crisis and other socioeconomic conditions (maternal selection, age, education of mothers, area of residence, health care utilization, household consumption, crime) [14,15], and Paxson and Shady [14] spoke about the quality of data on infant mortality in Peru. The quality of data on infant mortality affect not only the analysis, it creates a distorted outcome of reality from faulty data. The WHO’s ICD classification on data indicated that a completeness of 70-90% denotes medium quality data [16], which is the case for Jamaica [17,18]. In 2010, the Statistical Institute of Jamaica [19] opined that 4 out of every 5 infant deaths were estimated in the year the child was born and that the remaining was born in the previous year. The quality of infant mortality data in Jamaica is relatively reliable unlike what obtains in Peru [14].

The literature has provided empirical evidence that infant mortality data for Jamaica can be used to compare with those of other nations, by extension birth and death statistics [19]. It is documented that infant mortality is inversely related to economic recession in the United States, with the explanations being changes in maternal behaviour, composition of women giving birth and decline in air pollution [20-22]. The studies on infant mortality in Jamaica have not been on different explanatory variables as recession, maternal selection, age, education of mothers, area of residence, health care utilization, household consumption, and crime [17,18,23-25], which gives nothing for comparison with the literature. In 1992, the United Nations conducted a study on child mortality in the developing nations, including Jamaica [26], 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 [27] found that in Jamaica illness and child diarrhoea rates increase in economic downturns.

The data is available on infant mortality in Jamaica, yet no study is forthcoming on infant mortality, inflation, poverty, health care use, child mortality, gross domestic product (GDP) per capita growth, and 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 mortality. The present paper bridges the gap in the literature by examining all the previous mentioned issues, using data from 1989-to-2009 and from 1990-to-2000.

Methods

Empirical model

The model that is used to determine factors which account for infant mortality rates and child mortality rates is embodied in Waldman’s [15] theory. Waldman’s [15] theorized that log (infant mortality) = β₀ + β₁ log(Poor Income) + β₂ log(Middle Income) + γ Rich Share + 6 Year 1970.

For this research, log infant mortality (IMR) was expressed in eqn. (1), log child under 5 mortality rate (CMR) was modeled in eqn. (2), and logillness rate in eqn. (3):

\[ \text{LogIMR} = \beta_0 + \beta_1 \text{GDP per capita growth} + \beta_2 \text{HSB} + U_i \]  
\[ \text{LogCMR} = \beta_0 + \beta_1 \text{ln(poverty)} + \beta_2 \text{ln(Unemployment rate)} + \beta_3 \text{GDP per capita growth} + U_i \]  
\[ \text{lnIllness rate} = \beta_0 + \beta_1 \text{ln(poverty)} + \beta_2 \text{ln(Unemployment rate)} + \beta_3 \text{GDP per capita growth} + U_i \]

Where health seeking behavior (or health care utilization, HSB), \( \beta_3 \) is the constant and \( \beta_{1-3} \) are coefficients of factor, and \( U_i \) represents the error term.

Using 20-year data from 1990-2010, equations (4) and (5) model different under-five mortalities.

\[ \text{IMR} = ax^0 \]  
\[ \text{CMR} = ax^0 + bx + c \]  
\[ \text{lnCMR} = \ln(\alpha) + \beta \ln x \]  
\[ \text{lnIMR} = \ln(\alpha) + \beta \ln x \]  
\[ \text{lnIllness rate} = \beta \ln(poverty) + \beta \ln(Unemployment rate) + \beta \text{ln(GDP per capita growth)} + \beta \text{ln(ILLness rate)} + \beta \text{ln(Unemployment rate)} + \beta \text{ln(GDP per capita growth)} + U_i \]

Using annual data from 1992-2005, IMR was modelled within the context of the data – Eqn. (6):

\[ \text{CMR} = ax^2 + bx + c \]  
\[ \text{IMR} = ax + c \]  
Where is c is a constant, ‘a’ and ‘b’ represent coefficients of x, and x being time interval.

Using annual data from 1990-2000, IMR and CMR were modelled which are expressed in Eqs (7) and (8):

\[ \text{IMR} = ax + c \]  
\[ \text{CMR} = ax + c \]  
Where c is a constant, ‘a’ represents coefficients of x, and x being time interval.

Data source and management

The current work is a secondary data analysis, which collated data from various Jamaican Government Publications. Data sources were from Jamaica Survey of Living Conditions (JSLC) [28] on health care utilization (or health care seeking behaviour), illness rate and poverty; Economic and Social Survey of Jamaica on poverty [29]; and Statistical Digest on inflation [30]. The period for this work is from 1989-to-2009 and 1990-to-2000.

The JSLC is a jointly conducted by the Planning Institute of Jamaica (PIOI) and the Statistical Institute of Jamaica (STATIN) [28]. The JSLC is a nationally representative cross-sectional descriptive surveys drawn using stratified random sampling and comprised data on household’s characteristics, health, education, expenditure, social programmes, and other information. An administered questionnaire is to collect the data, and it is modelled from the World Bank’s Living Standards Measurement Study (LSMS) household survey [31]. There are some modifications to the LSMS, as JSLC is more focused on policy impacts.

The Economic and Social Survey of Jamaica (ESSJ) is publication which collates information on social and economic indicators of Jamaica. It is a publication by the Planning Institute of Jamaica. We
collected data mainly on unemployment rate in Jamaica from 1989 to 2009 [29].

Annual inflation rates for Jamaica were collected from Bank of Jamaica’s (BoJ’s) publication [30] and the Gross Domestic Product (GDP) information was had from the International Monetary Fund’s World Economic Outlook [32].

A data appendix accompanies this work that provides the conceptual definition of the main terms used in this paper.

Some abbreviations will be used throughout this work. They are CDR (crude death rate); IMR (infant mortality rate); CMR (child mortality rate); GDP per capita growth (gross domestic product).

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, according to the Statistical Institute of Jamaica 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 [19], which is 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) per 1000 of live births during a given period of time.

Illness rate is the percentage of Jamaicans who indicated having an illness in the survey year of the cross-sectional survey [28].

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 Window 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 ≤ 0.05). In any instance where collinearity existed (r > 0.7); the variables were entered independently into the model (Forward Stepwise method) 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 modeled by a linear, power, exponential or polynomial best fit function based on the data, with the aid of Excel. And 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 1960, IMR has been declining at a decreasing rate. IMR has exponentially declined between the early 1900s and late 1960s and beyond.

Figure 2 illustrates infant mortality rate from 1960 in 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 rate in Jamaica has been declining at an increasing rate, and then after 1950s, the rate has 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 progression (Figure 4).

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

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 compared to previous years as well as an increase the following years.

Figure 7 depicts that during decline in inflation rate 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 ($r_t = 0.767$, $P = 0.0001$), log IMR and log CMR ($r_t = 0.896$, $P < 0.0001$), and health care utilization and log CMR ($r_t = -0.793$, $P < 0.0001$).

Of the variables used, two factor emerged as explaining log infant mortality rate (GDP per capita growth), which account 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 InIllnessrate). Of the five (5) variables used in the model, three (3) emerged as statistical significant factors – Inpoverty ($P = 0.028$), Inunemployment ($P = 0.021$), and GDP per capita ($P = 0.028$). Unemployment and GDP are directly correlated to illness rate, with poverty being inverse 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 [27] found that “illness rates and child diarrhea rates increase during economic downturns”. Like Kim and Serra-Garcia [27], 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 mortality 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 [14] 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 [20-22]. Chay and Greenstone [20] 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, air pollution and 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 correlated with child mortality rate, which does not influence infant mortality rate. Clearly, when Smith and Kington [33] postulated that money can buy good health could seem like a logical explanation at the time for greater life expectancy in developed nations, particularly

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

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>HSB</th>
<th>lnInflation</th>
<th>lnPoverty</th>
<th>lnIMR</th>
<th>lnCMR</th>
<th>lnUnemployment</th>
<th>Illness rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSB</td>
<td>Pearson Correlation</td>
<td>1</td>
<td>-0.673*</td>
<td>-0.753*</td>
<td>-0.534</td>
<td>-0.793*</td>
<td>-0.412</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.001</td>
<td>0.000</td>
<td>0.015</td>
<td>0.000</td>
<td>0.063</td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>20</td>
<td>15</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>lnInflation</td>
<td>Pearson Correlation</td>
<td>-0.673*</td>
<td>1</td>
<td>0.677*</td>
<td>0.506*</td>
<td>0.696*</td>
<td>0.350</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.001</td>
<td>0.001</td>
<td>0.022</td>
<td>0.004</td>
<td>0.120</td>
<td>0.338</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>20</td>
<td>15</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>lnPoverty</td>
<td>Pearson Correlation</td>
<td>-0.753*</td>
<td>0.677*</td>
<td>1</td>
<td>0.506*</td>
<td>0.767*</td>
<td>0.473*</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.000</td>
<td>0.001</td>
<td>0.023</td>
<td>0.001</td>
<td>0.030</td>
<td>0.350</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>20</td>
<td>15</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>lnIMR</td>
<td>Pearson Correlation</td>
<td>-0.534*</td>
<td>0.506*</td>
<td>0.506*</td>
<td>1</td>
<td>0.896*</td>
<td>0.111</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.015</td>
<td>0.022</td>
<td>0.023</td>
<td>&lt;0.0001</td>
<td>0.640</td>
<td>0.493</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>lnCMR</td>
<td>Pearson Correlation</td>
<td>-0.793*</td>
<td>0.696*</td>
<td>0.767*</td>
<td>0.896*</td>
<td>1</td>
<td>0.156</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>&lt;0.0001</td>
<td>0.004</td>
<td>0.001</td>
<td>&lt;0.0001</td>
<td>0.578</td>
<td>0.318</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>lnUnemployment</td>
<td>Pearson Correlation</td>
<td>-0.412</td>
<td>0.350</td>
<td>0.473*</td>
<td>0.111</td>
<td>0.156</td>
<td>0.156</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.063</td>
<td>0.120</td>
<td>0.030</td>
<td>0.640</td>
<td>0.578</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>20</td>
<td>15</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Illness rate</td>
<td>Pearson Correlation</td>
<td>-0.494*</td>
<td>0.220</td>
<td>0.215</td>
<td>0.163</td>
<td>0.277</td>
<td>0.621*</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.023</td>
<td>0.338</td>
<td>0.350</td>
<td>0.493</td>
<td>0.318</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>20</td>
<td>15</td>
<td>21</td>
<td>21</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

### Table 2: OLS regression on variable that explain (or not) log IMR.

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

R² = 0.55
Adjusted R² = 0.30
F statistics = 9.396, P = 0.008
Dependent variable: log IMR
The statistical significant variables (P ≤ 0.05) are highlighted in purple

### Table 3: OLS of variable that explain (or not) log CMR.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>B coefficient</th>
<th>Std. Error</th>
<th>beta</th>
<th>P value</th>
<th>CI (95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3.28</td>
<td>0.492</td>
<td></td>
<td>0.001</td>
<td>2.08 - 4.49</td>
</tr>
<tr>
<td>HSB</td>
<td>0.00</td>
<td>0.004</td>
<td>-0.71</td>
<td>0.836</td>
<td>-0.01 - 0.01</td>
</tr>
<tr>
<td>Log Inflation</td>
<td>0.03</td>
<td>0.029</td>
<td>0.26</td>
<td>0.289</td>
<td>-0.04 - 0.10</td>
</tr>
<tr>
<td>Log Poverty</td>
<td>0.22</td>
<td>0.075</td>
<td>0.86</td>
<td>0.028</td>
<td>0.33 - 0.40</td>
</tr>
<tr>
<td>Log unemployment</td>
<td>-0.39</td>
<td>0.126</td>
<td>-0.63</td>
<td>0.022</td>
<td>-0.70 - 0.08</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>-2.66</td>
<td>0.984</td>
<td>-0.35</td>
<td>0.035</td>
<td>-5.07 - 0.25</td>
</tr>
<tr>
<td>Illness rate</td>
<td>0.03</td>
<td>0.012</td>
<td>0.61</td>
<td>0.05</td>
<td>0.00 - 0.06</td>
</tr>
</tbody>
</table>

R² = 0.90
Adjusted R² = 0.81
F statistics = 9.396, P = 0.008
Dependent variable: log CMR
The statistical significant variables (P ≤ 0.05) are highlighted in purple
the United States, cannot be wholesaled used to interpret better health status of those with more income. When Marmot [34] examined income and health in developed nations, using the United States, refuted the arguments of Smith and Kington when as 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" and that "... 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".

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 [33] 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 [33] 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 ill health. Unemployment which is greater among the poor than the non-poor in many societies is equally influencing the ill health rate of the population, and higher rate of ill health is impacted by money, suggesting that the lack of money (or access to it) is detrimental to child's 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 to the poverty-illness discourse.

The association between poverty and ill health is well documented in the literature. The WHO indicated that 4 out of every 5 people with chronic illnesses were in developing countries and that 3 of every 5 global mortality are caused by chronic illness [35]. This implies that there is an association between poverty and chronic illness, social deprivation and mortality. Such issues provide justifications for worsen health during economic crises [37-39].

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unstandardized Coefficients</th>
<th>Std. Error</th>
<th>beta</th>
<th>P</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnPoverty</td>
<td>-0.337</td>
<td>0.136</td>
<td>-0.624</td>
<td>0.028</td>
<td>-0.632 - 0.042</td>
</tr>
<tr>
<td>lnUnemployment</td>
<td>0.541</td>
<td>0.205</td>
<td>0.514</td>
<td>0.021</td>
<td>0.097 - 0.984</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>4.424</td>
<td>1.785</td>
<td>0.412</td>
<td>0.028</td>
<td>0.569 - 8.280</td>
</tr>
<tr>
<td>HSB</td>
<td>-0.012</td>
<td>0.007</td>
<td>-0.487</td>
<td>0.105</td>
<td>-0.027 - 0.003</td>
</tr>
<tr>
<td>lnInflation</td>
<td>0.011</td>
<td>0.069</td>
<td>0.040</td>
<td>0.879</td>
<td>-0.139 - 0.160</td>
</tr>
</tbody>
</table>

R² = 0.70
Adjusted R² = 0.60
F statistics = 6.083, P = 0.004
Dependent Variable: lnIllness Rate
The statistical significant variables (P ≤ 0.05) are highlighted in purple

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

that growth is good for the health of the poor has some merit. Unlike the literature, the present work found that poverty is inversely related to ill health as well as negatively correlated with child mortality rate and not statistical associated with infant mortality rate, suggesting poverty argument is complex and cannot be used to explain infant mortality rate in Jamaica.

The value of Dollar and Kraay's [44] 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 [44] perspective. With particularly results arising from economic expansion, it appears ironic that in prosperous times that health of children will be lowered 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 [20-22]. Paxson and Schady [14] 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 as well as owing to the industrial and technology revolution. Since the early 1900s at period of high prevalence and incidence of infectious diseases, the use of penicillin and advancement in public health measures such as sanitation, food and water quality, there is a transition from infectious to degenerate diseases, which all have a role in raising 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 [33] 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 ill health. Unemployment which is greater among the poor than the non-poor in many societies is equally influencing the ill health rate of the population, and higher rate of ill health is impacted by money, suggesting that the lack of money (or access to it) is detrimental to child's 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 to the poverty-illness discourse.

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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.

In summary, macroeconomic variables influence (or not) under-5 mortality in different ways and attention must be placed on poverty, inflation, GDP and unemployment as these provide public health specialists and policy makers with a comprehensive understanding of the working of those measures, and how to structure programmes in keeping with their changes.

Limitation

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.

References

44. Dollar D, Kraay A (2001) Growth is Good for the Poor. The World Bank, Washington, DC, USA.