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Factors affecting child mortality

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“Factors Affecting Child Mortality”

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Abstract

This study examines the factors that contribute to the rate of child mortality within a country. Through regression analysis, this model attempts to explain the rate of child mortality for a country as a function of factors including the adult female literacy rate, fertility rates, adult female labor force participation, rate of immunization for tuberculosis, access to safe water, income per capita, and prevalence of human immunodeficiency virus. This paper surveys a range of low-income countries from different regions including Sub-Saharan Africa, Middle East and North Africa, East Asia and the Pacific, Europe and Central Asia, South Asia, and Latin America. The data used in the study is gathered from reliable databases including the World Bank, the CIA World Fact Book, UNESCO, and the World Health Organization. It was found that the rate of fertility, adult female literacy rate, prevalence of HIV, and access to an improved water source all significantly impacted the rate of child mortality for a country. My intention with this study is to contribute towards, or confirm existing, research on this topic, and increase knowledge available for activists who can then have a more specific focus in their efforts to eliminate unacceptably high rates of child mortality.

I. Introduction

For several decades now, it has been understood that the level of development of a country must be measured by more than the one-dimension income statistics. Particularly, it is essential for the discussion of the development of a nation to include indicators that account for the well-being of the population as well as the economic and social state of the country. The rate of child mortality, defined as the number of deaths among children under the age of five per 1000 live births, has generally been considered an acceptable indicator of the overall health status of a population and by extension one measure of the level of development a country has achieved. The child mortality rate can also be a gauge of the effectiveness of public policies on health within a country and the policies' ability to serve the marginalized population.

Overall levels of child mortality have declined considerably over the last century through world-wide improved results in socio-economic conditions especially improved general healthcare for mothers and children. However there are many countries whose under-five mortality rates are still alarmingly high, specifically in low-income or developing countries. In these developing countries, child mortality accounts for a relatively large proportion of the total mortality for a country as compared to high-income countries, where child mortality accounts for only a small share of the total number of deaths. Several others have studied child mortality before and this paper builds upon that, taking the conclusions found in these previous studies and examining factors potentially affecting or contributing to the rate of under-five mortality within a country. Regression analysis is used to determine the significance of each factor on child mortality. This information can then be used to suggest areas for policy makers to consider when

seeking options for combatting child mortality in order to bring higher level of socioeconomic development.

II. Literature Review

There are numerous studies and articles available on the topics of infant and child mortality written over the last several decades. Gordon (2009) conducted a study of child mortality with a focus on Haiti. His study was conducted using data from a survey conducted by the Institute Haitien de l'Enfance, limited to a sample size of 2,271 women between the ages of 20 and 35. He used a binary dependent variable of child mortality where the mother was categorized as a zero if she had never lost a child and a one if she had lost at least one child. The independent variables included in their study were: the mother's years of education, income – measured by her possession of certain durable goods such as televisions, refrigerators, or telephones, her age, whether she resided in a rural or urban area, and access to sanitation. It concluded that higher levels of maternal education significantly decreased the probability of a child's death before the age of five, and inversely that as a mother's age increases, the likelihood of childhood mortality also increases.

Franz and FitzRoy (2006) also studied child mortality, though with a specific focus on the Central Asian Republics. They hypothesized that the environmental degradation in these Central Asian countries accounted for increased child mortality rates above that which would be determined by other socio-economic factors. They first estimated a model for fertility to control for any overlaps in the data, using the explanatory variables of access to contraception, female literacy rate, female participation

rate (female share of total labor force), health expenditure, and the Gini coefficient. This estimate was then used in the model for child mortality as an instrumental variable along with other factors including consumption of the poor (measuring real consumption of those living on less than two dollars per day), access to an improved water source and improved sanitation, female share of the population engaged in agriculture, prevalence of tuberculosis, and calories available per capita per day (to measure nutritional health). Data was analyzed for 61 developing countries, and they concluded that female literacy was important in explaining both fertility and child mortality, while also finding that consumption of the poor was also a significant determinant when controlling for nutrition, health expenditure, and income inequality. It was found that female agricultural labor participation rate and incidence of tuberculosis were both significant in explaining child mortality rates. They also found that despite included environmental controls, an estimated increase of 41% in child mortality was attributed to living in the Central Asian Republics.

Another study with a regional focus is Shandra *et al* (2011) which examined the effects of the World Bank Structural Adjustment program as well as water and sanitation access in sub-Saharan Africa on those countries' child mortality rates. The World Bank Structural Adjustment was a program in response to the debt crisis of the 1980s to alleviate the pressures of foreign debt on poor nations. The World Bank rescheduled loan payments and offered these countries new loans, but with requirements of new macroeconomic policy reforms. This study tested the hypothesis that these required policy reforms actually lead to higher rates of child mortality, though their original intent was economic growth for the sake of debt repayment. This study also tested the effects of

access to water and sanitation on the rates of child mortality. They used data for 31 countries at four time points (1990, 1995, 2000, and 2005) and developed a two-way fixed effects model for child mortality.

The explanatory variables used were a dummy variable to indicate if the country was a World Bank Structural Adjustment recipient, total debt service ratio (debt repayment as a percentage of exports), multilateral debt service ratio (debt repayment to only the International Monetary Fund and World Bank as a percentage of exports), multinational corporate investment, international trade (measured as exports and imports as a share of gross domestic product), access to an improved drinking water source, access to an improved sanitation facility, gross domestic product (GDP), domestic investment, secondary school enrollments, female secondary school enrollments, democracy (measured by Freedom House's political rights and civil liberties scale), public health expenditures, caloric intake, total fertility rate, and human immunodeficiency virus (HIV) prevalence. The authors were able to support their hypothesis that being a recipient of a World Bank Structural Adjustment loan adversely affected child mortality rates as well as confirming that higher levels of access to improved drinking water and sanitation facilities are associated with lower levels of child mortality. They also found fertility and HIV prevalence to have significant positive correlation with child mortality, while female education and income had significant negative impacts on the rate of child mortality. Nutritional levels were found to only have limited positive significance, and health expenditure and democracy were found to be statistically insignificant.

Oloo's study (2005) examined child mortality as a function of fertility rates, HIV prevalence, female literacy rates, GDP per capita, health expenditure per capita, immunization rates, proportion of doctors and nurses to the population, and access to safe drinking water. The data was taken from the Central Intelligence Agency, United Nations Children's Fund (UNICEF), World Health Organization, and the World Bank. Oloo confirmed positive relationships between child mortality and both fertility rates and HIV prevalence. He was also able to confirm negative relationships between child mortality and both female literacy and access to safe drinking water. GDP per capita, health expenditure per capita, immunization rates, and proportion of medical professionals were all found to be insignificant.

One study, conducted by Boehmer and Williamson (1996), focused on the impacts of different aspects of women's status on level of infant mortality. Their study was based on a sample of 96 countries with data from 1990 analyzed in a model developed based on gender stratification theory and industrialism theory. Their explanatory variables included measures of the level of economic development using the log of purchasing power of currencies estimates of gross domestic product per capita, women's educational status (illiteracy, school enrollments), women's political status (years with the right to vote, percent of seats in parliament), women's economic status, women's autonomy and independence within the family (age married, contraceptive prevalence, income inequality, percent of the population in urban areas, access to sanitation and health services, infants with low birth weights, percent of infants breast-fed, and per capita calorie supply. It was found that female secondary school enrollments had

the strongest negative relationship with infant mortality and crude birth rates the strongest positive effect. Women's economic activity also negatively affected infant mortality.

Hanmer *et al* (2003) reviewed existing studies on child mortality to test the common variables for robustness, indicating the probability that each determinant would be significant in a multivariate analysis of child mortality. The reviewed variables including population, fertility rate, crude birth rate, contraceptive prevalence, degree of urbanization, literacy rates, school enrollments, immunization rates, births attended by health professionals, proportion of infants with low birth weights, HIV prevalence, access to safe water, access to sanitation, proportion of physicians and nurses to the population, ratio of physicians to nurses, ratio of female to male for school enrollments, life expectancy, and literacy. They found that income per capita and tuberculosis immunization rates significantly reduced child mortality, which for this study in particular actually means that in the majority of analyses conducted, these variables will have the effect found here. Gender disparity in literacy has a significant negative effect on child mortality as well as female and male secondary school enrollments.

III. Data and Method

Based on the above literature, I selected variables for my model that were most common among these studies or seemed otherwise necessary to a model estimating child mortality. With this model my aim is to improve upon past research and therefore contribute to a better understanding of child mortality, its causes, and what can be done to lower rates worldwide. The following section details and defines the variables included in the model.

Dependent Variable – Child Mortality

Child mortality is measured using the under-five mortality rate (U5MORT). This variable is defined as the probability per one thousand live births that one newborn baby will die before reaching the age of five. Data for this variable was pulled for the year 2011 from the World Bank's World Development Indicators database.

Adult Female Literacy Rate

Based on the studies outlined above as well as other work emphasizing the impact of women's status on child mortality rates (Boehmer and Williamson), I have chosen to include the adult female literacy rate (LIT_F) as a proxy for female level of education. According to definitions from the United Nations Educational, Scientific and Cultural Organization (UNESCO) as well as the World Bank, this variable is defined as the percentage of the female population aged fifteen and up that can read and write with understanding, a short, simple statement concerning her everyday life. The data for this variable was gathered primarily from the World Bank's World Development Indicators database, but the database alone left gaps in the data. Data for missing countries was obtained either from the UNESCO Institute for Statistics website or the United States' Central Intelligence Agency (CIA) World Fact Book. Information about which source was used for each individual country's data is shown in Table 2. If available, the data was for 2011, but in some cases only data for the year 2010 was available. Female literacy is expected to have a negative impact on child mortality. Educated women are presumed to be better able to care for their children. They are more likely to seek professional medical treatment and make use of modern medical facilities, as well as be in communication

with medical professionals regarding the causes of illnesses of her children and ways to prevent them.

Total Fertility Rate

The total fertility rate per woman (FERTILITY) is described by the World Health Organization as the average number of children a woman would have if she lives through the end of her child-bearing years if she is subject her whole life to the fertility rates of a given time period. This statistic is expressed as children per woman. This data was obtained for the year 2011 from the World Health Organization's Global Health Observatory. Higher fertility rates are expected to increase child mortality because mothers have fewer resources available per child as she produces more and more children.

Adult Female Labor Force Participation Rate

According to Boehmer and Williamson, aspects of women's status within society, including but not limited to her educational status, will have an influence on mortality rates. They also note that women's economic power is the strongest indicator of women's overall status. For this study, women's economic power within a society will be measured by female labor force participation (LABOR_F). This rate is defined by the World Bank as the percent of the female population aged fifteen and up that is economically active in that they provide labor for the production of goods and services. This data was obtained for the year 2011 online from the World Bank's World Development Indicators database. In this particular case the data reported are modeled International Labor Organization estimates.

Prevalence of Human Immunodeficiency Virus

For a measure of the overall health of the population, I have included the prevalence of HIV (HIV) as an independent variable in this model. This is reported as the percentage of the population aged fifteen to forty-nine infected with HIV. This data was again obtained for the year 2011 online through the World Bank's World Development Indicators database. For this specific indicator, the World Bank used estimates by the United Nation Program on HIV/AIDS. The coefficient for the prevalence of HIV is expected to be positive, indicating that higher rates of infection – and the implied lower level of overall health for the population – would lead to higher rates of child mortality. This includes direct effects through infection of the children, passed to the child from an infected mother, who then may die from other diseases due to a weakened immune system, as well as indirect effects like that of younger children having infected parents who may be too sick to work and bring in resources to care for the children.

Rate of Immunization for Tuberculosis

Including a rate of immunization is another way to measure the overall health of the population, with a specific focus on the general level of healthcare for young children. I have chosen specifically immunization for tuberculosis (IMMUN) because of its status as a leading cause of death in the developing world and its reduction being a Millennium Development Goal set forth by the United Nations (Franz and FitzRoy). Tuberculosis immunization was also chosen based on the results of Hanmer *et al* as they found in their review of several studies of child mortality that specifically immunization for tuberculosis was a robust determinant of child mortality. The World Health Organization,

from whose Global Health Observatory the data for this variable was obtained, defines these reported data as the percentage of the one-year-old population who has received a Bacillus Calmette–Guérin vaccination as immunization against tuberculosis. The coefficient for the rate of immunization for tuberculosis is expected to be negative, indicating that as the number of one-year-olds receiving immunizations increases, the number of deaths due to tuberculosis would decrease leading to an overall decrease in child mortality.

Gross Domestic Product per capita

As is standard in these types of regressions, gross domestic product per capita (GDP_CAP) is included as a control variable in the model. Its inclusion is intended to ensure that any effects reported are independent of the nation's level of wealth and implicit level of development based on that wealth. The data for GDP per capita was obtained from the World Bank and is reported as GDP per capita based on the purchasing power parity. Data are for the year 2011 at constant 2011 international dollars. The GDP per capita coefficient is expected to be negative, indicating that higher levels of wealth bring about better medical facilities and technology as well as generally higher standards of living.

Access to an Improved Water Source

As noted above in my review of the analysis done by Shandra *et al*, access to an improved water source (WATER) has been proven to have a significant impact on lower rates of child mortality. In their study, Shandra *et al* offer some explanations on how

having clean water can directly and indirectly impact the health of children and the population as a whole. Not having access to improved water – defined by the World Bank as water from household pipes, public taps, tube wells, protected dug wells or protected springs, and rainwater collection – leads to children ingesting pathogens from polluted water sources causing various diarrheal diseases which reportedly kill around 2,000 children per day (Shandra *et al*). These conditions also lead to malnutrition and underweight children after experiencing repeated diarrheal infections. These unhealthy states make children more prone to contracting infectious diseases like malaria and tuberculosis. The data reported in this study is the percent of the population with access to an improved water source (as defined above) and was obtained for the year 2011 online from the World Bank's World Development Indicators database. It is hypothesized that this coefficient will be negative in that an increase in the availability of improved water sources will decrease the number of deaths by all the means stated above.

Data as described above for 74 low and middle income countries (listed in Table 2) from several different regions of the world were analyzed using a linear regression model. Only those countries for which data was available for all variables as detailed above were included so as to avoid problems that could occur from gaps in the data. The descriptive statistics are shown in Table 1 and a simple correlation matrix in Table 3.

The following regression model was estimated:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \varepsilon$$

where Y is the under-five mortality rate, α is the constant, and X_1 through X_7 represent the independent variables described above – the corresponding coefficients represented by β. X_1 is the adult female literacy rate, X_2 is the total fertility rate, X_3 is the adult

female labor participation rate, X_4 is the HIV prevalence, X_5 is the rate of immunization, X_6 is the GDP per capita, and X_7 is the access to improved water.

Table 1 – Descriptive Statistics

Summary Statistics, using the observations 1 - 74

Variable	Mean	Median	Minimum	Maximum	Std. Dev.
U5MORT	59.1081	51.8	6.9	177.5	43.2575
LIT_F	72.3953	80.1828	17.6121	99.8	23.15
FERTILITY	3.59608	3.33	1.37	6.85	1.5639
LABOR_F	55.6568	55.45	15.6	88.2	16.3721
HIV	2.96486	0.75	0.1	27.4	5.40346
IMMUN	91.1486	96.0	46.0	99.0	11.0969
GDP_CAP	6139.28	4564.73	656.787	21074.9	5063.43
WATER	80.6446	84.2500	39.2	99.8	15.6162

Table 2 – Countries in the Sample – by World Bank Regional Groups

East Asia and Pacific	Sub-Saharan Africa
Indonesia	Angola
Malaysia	Benin
Mongolia	Botswana
Papua New Guinea	*Burundi*
Thailand	Cabo Verde
Vietnam	Central African Republic
	Chad
	Cote d'Ivoire
Middle East and North Africa	**Congo, Republic of**
Egypt	*Democratic Republic of Congo*
Morocco	Gabon
Tunisia	Gambia
Yemen	Ghana
	Guinea

South Asia
Afghanistan
Bangladesh
Nepal
Pakistan
Sri Lanka

Europe and Central Asia
Albania
Armenia
Azerbaijan
Georgia
Macedonia
Moldova
Tajikistan
Serbia
Ukraine
Uzbekistan

Latin America
Bolivia
Colombia
Costa Rica
Cuba
Dominican Republic
Ecuador
El Salvador
Guatemala
Honduras
Jamaica
Mexico
Panama
Paraguay
Guinea-Bissau
Kenya
Lesotho
Liberia
Malawi
Mali
Mauritius
Mozambique
Namibia
Nigeria
Rwanda
Sao Tome and Principe
Sierra Leone
Senegal
South Africa
Sudan
Swaziland
Tanzania
Togo
Uganda
Zambia
Zimbabwe

*Literacy rate data was retrieved from the following sources: for plain text countries – UNESCO; for **bold** countries – The World Bank; for countries in *italics* – CIA World Fact Book.

IV. Results

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evidenced by the adjuste ... f the
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Table 3 – Correlation Matrix

Correlation coefficients, using the observations 1 - 74
5% critical value (two-tailed) = 0.2287 for n = 74

U5MORT	LIT_F	FERTILITY	LABOR_F	HIV	IMMUN	GDP_CAP	WATER	
1.0000	-0.7470	0.8377	0.3563	0.3013	-0.5148	-0.6354	-0.7486	U5MORT
	1.0000	-0.7626	-0.1688	0.0426	0.4741	0.6291	0.6390	LIT_F
		1.0000	0.4234	0.1933	-0.4691	-0.6756	-0.7636	FERTILITY
			1.0000	0.2481	0.0953	-0.4316	-0.3777	LABOR_F
				1.0000	-0.0657	-0.1633	-0.1713	HIV
					1.0000	0.2711	0.4707	IMMUN
						1.0000	0.6120	GDP_CAP
							1.0000	WATER

participation rate, the rate ... were all
found to be statistically i ... alence of
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the dependent variable, n ... will lead to

reductions in the likelihood of child mortality. The coefficients of the independent variables are interpreted to say that, for example, a one percent increase in the prevalence of HIV in a country, which has a coefficient of 1.56, brings a 1.56% increase in that nation's under-five mortality rate. However if the variable is not measured in percentage points, like fertility rate for example, this definition does not hold. For the fertility rate, which is measured in children per woman and has a coefficient of 9.82, this is interpreted to say that for each additional child added to the average number of children a woman of that country will have, there will be a 9.82% increase in that country's under-five mortality rate. The inverse is also true when dealing with variables that have negative coefficients. Using the example of the literacy rate with a coefficient of -0.56, for every one percent increase in the literacy rate for a country, there can be expected to follow a 0.56% decrease in the under-five mortality rate for that country.

Table 4 – Regression Results

Model 1: OLS, using observations 1-74
Dependent variable: U5MORT

	Coefficient	*Std. Error*	*t-ratio*	
const	131.816	35.7521	3.6870	***
LIT_F	-0.569144	0.185645	-3.0658	***
FERTILITY	9.81647	3.19672	3.0708	***
LABOR_F	0.117925	0.189107	0.6236	
HIV	1.56336	0.483806	3.2314	***
IMMUN	-0.431629	0.275185	-1.5685	
GDP_CAP	-0.00016873	0.000708453	-0.2382	
WATER	-0.466564	0.25366	-1.8393	*

R-squared	0.795221	F(7, 66)	36.61421	Adjusted R-squared	0.773503

The asterisks in the table indicate significance of the variable in a two tailed test. Three asterisks denote significance at the 99% level of confidence, two asterisks indicate significance at the 95% level and one asterisk implies significance at the 90% level. The insignificance of the variable female labor force participation may suggest that another measure should be sought as a more suitable to proxy for women's economic activity. Likewise another indicator of national income per capita, perhaps instead a measure of income, may be more appropriate for these analyses than GDP per capita. Its insignificance may also be a result of its correlation with other variables as shown in Table 3. However, simply because GDP per capita was statistically insignificant it does not necessarily mean that its effects (i.e. the effects of higher income) are not secondarily influencing other variables. At the very least, it is understood that certain wealth growth is necessary to support and maintain social and welfare growth. It is however, important then to focus that wealth growth into certain proven social initiatives that will bring about welfare improvements. I was surprised to see that the rate of immunization was statistically insignificant. I currently do not have possible explanations for this and would be interested in investigating this relationship between immunizations and child mortality further.

The significances of each variable may be currently altered due to the problem of multicollinearity in the model, evidences by the number of variables with correlations greater than 0.5 in the matrix included in Table 3. To investigate this problem further, I ran multiple regressions with different combinations of variables, omitting at different points each variable with high correlations to other variables. I was ultimately no more

satisfied with any of those models than with my current model and therefore chose to continue with the original model included in this paper.

V. Conclusions

Based on the results above, and considering that the fertility rate and the prevalence of HIV had the two largest coefficients, my conclusion would be to suggest social policies targeting more widespread information and availability on contraception and other reproductive health matters. Increasing women's and families' knowledge of topics such as birth spacing and improving their access to safe and reliable contraceptive measures would be expected to lower fertility rates and allow for more resources to be available for each child, but could also slow the spread of HIV within a country. Bearing in mind also the significance of the female literacy rate and its implications about female education, policy initiatives aimed at increasing women's education could also significantly reduce child mortality rates. Not only would it increase the chances of her being knowledgeable about birth control options and general reproductive health, but it would also increase her chances of being able to provide the best possible care for the children she does have. Another policy focus should be general gender-equality initiatives, or more specifically, increasing women's autonomy. This has been shown to reduce fertility rates (Boehmer and Williamson), but would also likely increase the chance that women would receive proper education. In addition, programmes intended to bring safe water to more of the population should also be targeted. Children with access to safe water have a better chance of avoiding fatal diarrheal diseases, malnutrition from repeated diarrheal infections, fatal infectious diseases from weakened immune systems,

as well as having a better chance at staying in school instead of gathering water from long distances. Again remembering the findings concerning GDP per capita, it is important to note that all of these social policy initiatives should also be accompanied by wealth growth, suggesting however that these policies will produce welfare improvements more quickly than wealth growth alone. Lastly, it is important to mention some evident limitations within this study. I have already noted the possible improvements that can be made concerning model specification and that other indicators may be more suitable in some cases. Additionally, if more data were available, a suggested expansion might be trying this study with a larger sample. Alongside these improvements, I would be interested to see the results of a study on this topic using panel data, spanning several countries over several years' time.

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