Health Care Expenditures and Mortality Rates in Developing Countries

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Abstract

This study investigates the relationship between health care expenditures and mortality in developing countries. In addition, the difference in impact of public and private expenditures is investigated. This study uses country level aggregated data from developing countries, as defined by the World Bank's 2021 income classification system, over a 15-year period from 2003 to 2018. The results indicate that total health care expenditures per capita have a significant negative correlation with infant mortality but a significant positive correlation with adult mortality. In all populations, higher percentages of out-of-pocket expenditures increased mortality rates, while higher levels of public expenditures showed a significant negative correlation with mortality rates. Additionally, higher levels of private expenditures consistently showed a positive correlation with mortality rates.

Introduction

Mortality rates are a key indicator of a nation's health status. Although mortality rates have been declining around the world, this progress has been much faster in developed nations than it has been for those nations that are still developing. Developing nations account for a large percentage of the world's premature deaths, many of which are caused by ailments that are preventable or treatable with the proper resources (*The top 10 causes of death*, 2020). According to the World Health Organization, 60% of people in developed countries lived to at least age 70 compared to only 30% of people in developing countries (*The World Health Report 2003 – Shaping the Future*, 2003). This statistic was based on 2003 and raised a rather alarming issue. According to data from 2019, the average life expectancy for high income countries 80.89 years compared to 71.21 years in low- and middle-income countries. This is a difference of 9.68 years. While this gap has shrunk significantly in the last 60 years, from a difference of 21.35 years in 1960, a clear disparity still exists. This is especially pronounced when looking at the difference between life expectancy between high income countries and low-income countries alone in the year 2019. This difference is 17.16 years (World Bank, 2020). This raises the question of why this disparity exists and what can be done to change it.

One clear factor in health outcomes is a countries level of health care expenditures. To acquire the necessary infrastructure and resources to improve health care takes money and the question is how exactly that influences mortality in a country. Previous literature indicates that health care expenditures have a significant impact on these outcomes. Some studies have even raised the point that where the money comes from is also significant in how it impacts the health of a nation's residents, citing public expenditures as more important in developing countries (Dhrifi, 2019). Essentially, it is important to understand this relationship as a way to implement

necessary change and potentially gain insight into what policies may help improve the efficiency and overall outcome of health care in these developing nations.

To do this, data pertaining to mortality rates and health care expenditures per capita was obtained for 115 developing countries as defined by the World Bank's 2021 income classification system. Expenditure variables were divided up into total, public, private, and out of pocket variables to examine the differences in expenditure sources. Control variables were also collected for economic, environmental, lifestyle, and education factors based on previous literature.

The goal of this paper is to establish a relationship between health care expenditures and mortality rates and determine what the impact of various expenditure variables are on these outcomes. The hypothesized relationship was that increasing health care expenditures should be significant in lowering mortality rates. Rather, this study found that where expenditures are coming from to be the most significant for determining the impact of expenditures on mortality rates. By splitting total health care expenditures into public and private expenditures variables in a second set of regressions, it was determined that increased public health care expenditures were correlated with decreased mortality rates while increased private health care expenditures were correlated with increased mortality rates. Larger percentages of out-of-pocket spending were also corelated with increased mortality rates. As a result, the conclusion can be drawn that the origin of expenditures is important for determining their impact. Particularly, greater burden being placed on the consumer is likely to lead to less improvements in health outcomes.

Literature Review

Health care expenditures vary vastly from country to country and the same can be said about the health outcomes in these countries. Much research has been done to try to correlate

national levels of health care expenditures with overall health outcomes for the population of a given country. Interest in this topic has its roots in the Grossman (1972) health capital model. This model presents health as a durable good that depreciates with time and sets health apart as its own distinct form of human capital. This model also suggests that improved health outcomes have a significant impact on human capital development. It also implies that good health improves overall productivity and returns on investments for a population (Grossman, 1972).

There is also evidence that poor health status is correlated with negative effects on welfare of a population (Novignon et al., 2012). For this reason, health expenditure's effect on health outcomes becomes a very important topic of research. Results from these studies are particularly important because they can have very useful policy implications for nations. These studies have yielded mixed results. Some of these studies have failed to find a significant relationship between health care spending and health outcomes (Burnside & Dollar, 1998). These older studies, however, failed to control for a number of sociodemographic and environmental variables that have been addressed in many more recent studies.

There are a number of ways to measure health outcomes in a population. The most common way is life expectancy. Another metric that is commonly used is infant mortality, defined as the mortality rate for children under the age of one. A third, though less common metric is the under-five mortality rate which is defined as the mortality rate for children under the age of five. Gallet and Doucouliagos (2017) reviewed the results of 65 studies that estimated a correlation between health care expenditure and both life expectancy and mortality. In the majority of these studies there was found to be a significant positive correlation with measures of life expectancy and a significant negative correlation with mortality indicators. Though it is interesting to note that some studies have found that health care expenditures seem to have a

greater impact on changes in mortality indicators than those of life expectancy (Crémieux et al., 1999, Nixon and Ulmann, 2006).

When analyzing life expectancy variables, one can look either at life expectancy from birth or life expectancy from an older age. Life expectancy from older ages has been found by some studies to be much more sensitive to changes in health care expenditures therefore making it a more interesting variable to research (Asiskovitch, 2010). This is likely due to advances in care for medical conditions likely to affect an older population.

The metric for measuring health care expenditure itself has also varied greatly across the studies. Some studies have looked at total health care spending while others have investigated health care spending as a share of GDP. A third method is to measure health care spending per capita. Some studies have looked at all three. Another metric that has been used is spending on pharmaceuticals. In a study by Crémieux et al. (2004), both private and public pharmaceutical spending in Canada were used as expenditure metrics. The results found pharmaceutical spending to be a significant indicator of decreased infant mortality and increased life expectancy at 65. Across these studies, the most consistently used metric has been health care expenditures per capita. This is the most relevant metric as it gives an accurate depiction of how much a country invests, on average, into the health of each individual citizen.

Some studies have investigated differences in effects of private and public health care expenditures. Many of these studies have found minimal differences when looking at these metrics (Leigh and Jencks, 2007, Caliskan, 2009) but some have determined that public health care spending has a greater impact than private spending (Gupta et al., 2002, Lichtenberg, 2004). In a study of OECD countries, Or (2000) found that “[t]he way health expenditure is financed also appears to affect health outcomes; a larger share of public financing of healthcare is

associated with lower rates of premature mortality for both sexes" (p. 63). A study by Dhrifi (2019) also found differences in results for private versus public health care spending's effect on under-five mortality rates when countries were grouped together based on income level. This distinction proved most important, however, to a study conducted by Raeesi et al. (2018) that investigated the impact of both private and public health care spending in four different health care systems. The results of the analysis found that public and private health care expenditures had different levels of impacts based on the health care system in which they were implemented. The key findings were that countries with mixed health care systems benefit most from increases in private health care expenditures while national health service systems benefit most from increases in public health care expenditures. This study does bring up an interesting variable that would be worth investigating further given the findings that the effect on health outcomes is sensitive to the system in which the spending is taking place.

Many studies have found significant relationships between health care expenditure metrics and health outcomes. An international study by Jaba et al. (2014) found a significant relationship between life expectancy and health care expenditures without controlling for any lifestyle, education, or income factors. Many other studies, however, have found significant relationships while controlling for a number of outside factors that were also determined to have influences on health outcomes. A nation's status as either a developed of developing country is a common variable that has been debated, with some finding it significant (Jaba et al., 2014) while other have found it to be insignificant in their models (Duba et al., 2018). This specific metric likely warrants further research.

Environmental variables like CO_2 emissions per capita have found to be significant in determining health outcomes in some studies (Dhrifi, 2019) but not in others (Duba et al., 2018).

GDP per capita is often cited as an important variable in relation to health outcomes but as Or (2000) points out, “it is difficult to isolate the true impact of health expenditure on health outcomes because of the strong collinearity between health expenditure and GDP per capita” (p. 63). When GDP per capita was dropped from his regression model, health expenditures became highly significant for both males and females (Or, 2000). Measuring GDP growth instead may be a way to get around this problem and some studies have found it to be a significant variable (Dhrifi, 2019).

Level of education is often found to be significant and can be accounted for by literacy rates or primary school completion rates (Chireshe & Ocran, 2020). This variable is important because better educated individuals have the knowledge to make better health and lifestyle related decisions and have demand for health care in the first place (Grossman, 1972). Health financing, and basic infrastructure have also been found to be key determinants of health outcomes (Chireshe & Ocran, 2020). Though these external variables are important, a study conducted by Crémieux et al. (1999) across Canadian provinces found very similar results that followed the same trends both when controlling for and omitting lifestyle and nutritional data controls.

There have been studies that have investigated if there is a difference between changes of male and female health outcomes in response to health care expenditure changes. Some of these studies have found that changes in health care expenditures have a greater impact on male health outcomes (Crémieux et al., 1999). Other studies have found women’s health outcomes to be more sensitive to changes in health care spending (Ivaschenko, 2005). Still some studies have failed to find any significant difference between male and female health outcomes in response to health care spending changes (Nixon and Ulmann, 2006).

The current literature relating health care expenditures to health outcomes has been conflicting but relatively consistent in finding that some relationship between the two variables does exist. The big question left to answer is how strong this relationship truly is. By controlling for a number of variables that different studies have found to be significant in influencing health outcomes, the full extent of this relationship can be more clearly determined.

Data and Methodology

This study aims to establish a relationship between health care expenditures and mortality rates in developing countries. It is expected that greater health care spending in these developing countries will be associated with lower mortality rates. Beyond just establishing the relationship between overall spending and mortality rates, the study also aims to analyze whether or not how health care is financed has any significant effect on these outcomes. To study the impact of health care expenditures on health outcomes in developing countries, data was collected from 89 developing countries, determined based on the World Bank's 2021 income classification system, over a 15-year period from 2003 to 2018. The data was assembled using the World Bank's World Development Indicators data set, the United Nations Human Development Reports, and International Disaster Database (EM-DAT).

The countries in the sample were classified as developing based on the World Bank's 2021 income classification system. This system divides countries into low income (<$1,046), lower-middle income ($1,046-$4,095), upper-middle ($4,096-$12,695), and high income (>$12,965) based on a country's GNI (gross national income) per capita in current US dollars. Using this classification system, countries below the high-income bracket are considered to be developing. The sample was collected based on data availability from those countries in the low income, lower-middle income, and upper-middle income brackets.

Health outcomes were measured by four mortality indicators which serve as dependent variables in each regression. Both the adult male mortality rate and the adult female mortality rate were obtained. This is defined as the number of deaths under age 60 per 1,000 people alive at age 15 (this will be referred to as "per 1,000 adult males" and "per 1,000 adult females" respectively in this paper). The infant mortality rate was used, which is the number of infants who die before the age of one per 1,000 live births. The fourth and final mortality indictor used was the under-five mortality rate which measures the number of deaths for the population below the age of five per 1,000 live births.

The main independent variables of interest are measures of health care expenditures in a country. There are multiple ways in which to measure this variable and so four different versions of this variable were collected. The most inclusive of these variables is total health care expenditures per capita which is measured in 2018 US dollars. This variable measures health care spending in the most general sense and is expected to have a negative correlation with mortality indicators. To see the differences in impact between private and public health care expenditures, a variable was collected for each of these expenditure sources. One of these variables was private health care expenditure per capita. This includes spending from households, insurance, and private organizations. The other variable is public domestic healthcare spending per capita. This includes all spending on health care by the government and other public entities in a country. Both of these variables are expected to have a negative correlation with mortality indicators. The fourth expenditure variable of interest was out of pocket payments as a percentage of total health care expenditures. This variable includes only spending that comes from households directly and was obtained directly from the World Bank. This variable is expected to have a positive correlation with mortality indicators because there is

the potential that having to pay more out of pocket will discourage people from seeking the health care that they need.

To deal with correlation issues that will be present in these expenditure variables two different sets of regressions will be run. The first set of regressions will include total health care spending per capita as well as the out-of-pocket expenditures as a percentage of total expenditures variable. The second set of regressions will focus on the difference between public and private spending and thus will include the private expenditure per capita variable as well at the public domestic expenditure per capita variable.

There are a number of other factors that could influence mortality rates in developing countries that should also be factored into the regression models. These variables can be divided into five categories: economic factors, disease related factors, health financing, environmental factors, and education.

The first economic factor for which data was collected was GNI per capita in 2018 US dollars calculated by the World Bank using the Atlas method. This provides a rough estimate of income per person in a country which can influence how much money individuals have to spend on healthcare. This is expected to have a negative correlation with mortality rates because if more resources are available to the individual, they are more likely to seek out medical care that they need. Additionally, higher GNI per capita could be a sign that one is more likely to be able to make a living in their country. This could potentially reduce rates of emigration as people are more willing to stay and start their businesses in these places where they feel they can earn a decent living. This would include high skill jobs like health care professionals as well. If these doctors are able to make a good living in their home country, they are less likely to go abroad to practice. As a result, this increase in number of physicians per capita could increase availability

and access to care resulting in improved health outcomes. Another economic variable that will be controlled for is annual GDP growth as a percentage of GDP. This indicates how a country's economy is doing in a given year which can influence the amount of money available in a country to improve health care. This is also expected to have a negative correlation with mortality rates because if a country has more resources, they are more likely to have the ability to spend more money on improving health care in the nation. Higher GDP in a country could also be correlated with a number of other improvements to the nation if the money is properly spent. One of these things could be improved infrastructure which would make it easier for people to get around the country and improve access to a number of important resources. This could include things like clean water access. Additionally, this could make access to potentially limited health care more readily available. By providing people with better ability to access health care, the resources a country does have are more likely to be used by a greater share of the population which should lead to better health outcomes.

For disease related factors, data on the prevalence of HIV measured per 1,000 uninfected people and the prevalence of tuberculosis per 100,000 people were collected. These were chosen because these diseases are quite common and devastating in developing countries but can be safely managed with the proper resources, though these are less common in developing countries. These variables are both expected to have a positive correlation with mortality rates because if the prevalence of these devastating diseases rise in a country without the resources to treat them, it is likely to lead to poor health outcomes for the population. Data was also collected pertaining to rates of DTP vaccination as a percentage of children ages 12-23 months. This is a combination vaccination for diphtheria, tetanus and pertussis. This vaccine is recommended to be given in the first year of life because pertussis, also known as whooping cough, can be

particularly fatal to young children. This variable is expected to have a negative correlation with mortality rates because it will decrease the rates of these diseases and make symptoms more manageable in the event of infection. It is expected that this variable will have a much more substantial effect on infant mortality and under five mortality because of how particularly serious pertussis infection can be for younger children. The variable is also expected to have a negative correlation with adult mortality rates because this vaccination rate is also suspected to be indicative of the overall vaccine environment in a given country.

The environmental factors controlled for include the percentage of the population with access to basic sanitation and the percentage of the population with access to basic drinking water. These are both important resources for meeting the needs of citizens and reducing their exposure to pathogens from waste. Both of these variables are expected to have a negative correlation with mortality rates because increasing access to essential resources and decreasing exposure to pathogens should improve health in a population.

Data was also collected related to education. In order to measure this, data was obtained from the United Nations Human Development Report pertaining to the average years of schooling in a population for people age 25 and older. This data was split up by gender. For the years 2000 through 2010 the data was only reported in five-year increments and then every year for the years 2011 through 2018. To convert these statistics to annual data a constant growth rate was assumed for each five-year period. The education data for males will be used as a control in the regressions with adult male morality rates. The education data for females will be used as a control in the regressions with adult female mortality rates, infant mortality rates, and under five mortality rates. This is because the literature has shown the mother's education to be more explanatory in the health outcomes of children than the father's education. These education

factors are expected to have a negative correlation with mortality rates because having a better education can make people more likely to know when and how to seek out necessary health care as well as making people more likely to make better decisions about their health.

A final variable that must be controlled for given the nature of the dependent variable is natural disasters. It must be taken into account how mortality rates may dramatically increase in country for a year due to an event such as an earthquake or an outbreak of a particularly fatal disease. To control for this data was obtained from the International Disaster Database (EM-DAT). It was noted when a natural disaster event in a country caused a significant death toll in a given year, defined as an event leading to greater than 1,000 deaths. This was then implemented in the data set as a dummy variable, where 1 indicates a significant disaster event and 0 indicates no significant disaster event took place that year.

Below the regression equations for each of the eight regression models are given followed by a chart indicating variable abbreviations and expected correlations.

Model 1: Infant Mortality with Total Health Expenditures Per Capita and Percent Out of Pocket Expenditures

$$infantmortality_t = \beta_0 + \beta_1 lntotalHCEpc_t + \beta_2 OOPE_t + \beta_3 DTPrate_t + \beta_4 HIVprev_t + \beta_5 TBprev_t + \beta_6 basicsan_t + \beta_7 basicwat_t + \beta_8 GDPgrow_t + \beta_9 lnGNIpc_t + \beta_{10} avgschoolF_t + \beta_{11} NDE_t + u_t$$

Model 2: Under Five Mortality with Total Health Expenditures Per Capita and Percent Out of Pocket Expenditures

$$underfivemortality_t = \beta_0 + \beta_1 lntotalHCEpc_t + \beta_2 OOPE_t + \beta_3 DTPrate_t + \beta_4 HIVprev_t + \beta_5 TBprev_t + \beta_6 basicsan_t + \beta_7 basicwat_t + \beta_8 GDPgrow_t + \beta_9 lnGNIpc_t + \beta_{10} avgschoolF_t + \beta_{11} NDE_t + u_t$$

Model 3: Adult Female Mortality with Total Health Expenditures Per Capita and Percent Out of Pocket Expenditures

$$adultfemalemortality_t = \beta_0 + \beta_1 lntotalHCEpc_t + \beta_2 OOPE_t + \beta_3 DTPrate_t + \beta_4 HIVprev_t + \beta_5 TBprev_t + \beta_6 basicsan_t + \beta_7 basicwat_t + \beta_8 GDPgrow_t + \beta_9 lnGNIpc_t + \beta_{10} avgschoolF_t + \beta_{11} NDE_t + u_t$$

Model 4: Adult Male Mortality with Total Health Expenditures Per Capita and Percent Out of Pocket Expenditures

$$adultmalemortality_t = \beta_0 + \beta_1 lntotalHCEpc_t + \beta_2 OOPE_t + \beta_3 DTPrate_t + \beta_4 HIVprev_t + \beta_5 TBprev_t + \beta_6 basicsan_t + \beta_7 basicwat_t + \beta_8 GDPgrow_t + \beta_9 lnGNIpc_t + \beta_{10} avgschoolM_t + \beta_{11} NDE_t + u_t$$

Model 5: Infant Mortality with Private and Public Health Expenditures Per Capita

$$infantmortality_t = \beta_0 + \beta_1 lnprivHCEpc_t + \beta_2 lnpubHCEpc_t + \beta_3 DTPrate_t + \beta_4 HIVprev_t + \beta_5 TBprev_t + \beta_6 basicsan_t + \beta_7 basicwat_t + \beta_8 GDPgrow_t + \beta_9 lnGNIpc_t + \beta_{10} avgschoolF_t + \beta_{11} NDE_t + u_t$$

Model 6: Under Five Mortality with Private and Public Health Expenditures Per Capita

$$underfivemortality_t = \beta_0 + \beta_1 lnprivHCEpc_t + \beta_2 lnpubHCEpc_t + \beta_3 DTPrate_t + \beta_4 HIVprev_t + \beta_5 TBprev_t + \beta_6 basicsan_t + \beta_7 basicwat_t + \beta_8 GDPgrow_t + \beta_9 lnGNIpc_t + \beta_{10} avgschoolF_t + \beta_{11} NDE_t + u_t$$

Model 7: Adult Female Mortality with Private and Public Health Expenditures Per Capita

$$adultfemalemortality_t = \beta_0 + \beta_1 lnprivHCEpc_t + \beta_2 lnpubHCEpc_t + \beta_3 DTPrate_t + \beta_4 HIVprev_t + \beta_5 TBprev_t + \beta_6 basicsan_t + \beta_7 basicwat_t + \beta_8 GDPgrow_t + \beta_9 lnGNIpc_t + \beta_{10} avgschoolF_t + \beta_{11} NDE_t + u_t$$

Model 8: Adult Male Mortality with Private and Public Health Expenditures Per Capita

$$adultmalemortality_t = \beta_0 + \beta_1 lnprivHCEpc_t + \beta_2 lnpubHCEpc_t + \beta_3 DTPrate_t + \beta_4 HIVprev_t + \beta_5 TBprev_t + \beta_6 basicsan_t + \beta_7 basicwat_t + \beta_8 GDPgrow_t + \beta_9 lnGNIpc_t + \beta_{10} avgschoolM_t + \beta_{11} NDE_t + u_t$$

Table 1. Variable Names with Regression Equation Abbreviations and Expected Correlations

Variable Names	Abbreviation in Regression Equation	Expected Correlation
ln(Total Health Care Expenditures per capita)	lntotalHCEpc	Negative
ln(Private Health Care Expenditures per capita)	lnprivHCEpc	Negative
ln(Public Health Care Expenditures per capita)	lnpubHCEpc	Negative
Out of Pocket Health Expenditures (% of Total Expenditures)	OOPE	Positive
DTP Immunization Rate (%)	DTPrate	Negative
Incidence of HIV	HIVprev	Positive
Incidence of Tuberculosis	TBprev	Positive
Access to Basic Sanitation	basicsan	Negative
Access to Basic Drinking Water	basicwat	Negative
Annual GDP Growth (%)	GDPgrow	Negative
ln(GNI per capita)	lnGNIpc	Negative
Average Years of Schooling (male)	avgschoolM	Negative
Average Years of Schooling (female)	avgschoolF	Negative
Natural Disaster Event	NDE	Positive

Results

The research question was investigated by running eight separate ordinary least squares regression, which can be divided into two groups of four regressions. Four different mortality indicators were used in these regressions which included infant mortality per 1,000 live births, under-five mortality per 1,000 live births, adult female mortality before age 60 per 1,000 alive at age 15, and adult male mortality before age 60 per 1,000 alive at age 15. The first group of regressions focused on total health care expenditures per capita and out of pocket expenditures as a percentage of total health care expenditures as the main variables of interest. The second group of regressions focused on investigating the effect of the source of expenditures, using public

health care expenditures per capita and private health care expenditures per capita as the main variables of interest. In these regressions a few expenditures variables demonstrated a skewed distribution. To account for this, these variables were converted into natural logarithms. Each regression was also tested for heteroskedasticity, which was found to be a concern in all eight regressions. To account for this each regression was run using robust standard errors.

Total Health Care Expenditures Per Capita and Out of Pocket Expenditures

The first group of regressions that was run were those that investigated the effect of total health care expenditures and out of pocket expenditures as a percentage of total expenditures. Each regression in this group contained 1,209 observations. Factors controlled for include disease variables, immunization variables, economic variables, education level, and access to basic services. Natural disaster events and variation by year were also controlled for in these regressions using dummy variables.

Table 2. Total Health Care Expenditures Per Capita and Out of Pocket Expenditures Regression Results

	Infant Mortality (per 1,000 live births)	Under Five Mortality (per 1,000 live births)	Adult Female Mortality (per 1,000 adults)	Adult Male Mortality (per 1,000 adults)
Constant	122.15*** (6.46)	185.03*** (10.67)	328..45*** (30.42)	347.53*** (33.98)
ln(Total Health Care Expenditures per capita)	-2.42* (1.45)	-1.87 (2.25)	9.69* (5.76)	16.98*** (5.72)
Out of Pocket Health Expenditures (% of Total Expenditures)	0.26*** (0.03)	0.38*** (0.05)	0.57*** (0.14)	0.44*** (0.13)
DTP Immunization Rate (%)	-0.33*** (0.05)	-0.47*** (0.08)	0.15 (0.21)	0.63*** (0.23)
Incidence of HIV	1.58*** (0.33)	3.61*** (0.59)	15.54*** (2.10)	13.83*** (2.35)
Incidence of Tuberculosis	0.001 (0.003)	-.007 (0.005)	0.08*** (0.02)	0.14*** (0.02)
Access to Basic Sanitation	-0.25*** (0.03)	-0.45*** (0.04)	-1.46*** (0.12)	-0.77*** (0.12)
Access to Basic Drinking Water	-0.03 (0.07)	-0.11 (0.04)	0.02 (0.31)	0.02 (.30)
Annual GDP Growth (%)	-0.35*** (0.12)	-0.71*** (0.20)	-1.94* (0.49)	-0.95* (0.51)
ln(GNI per capita)	-5.09*** (1.35)	-8.22*** (2.14)	-22.88*** (5.83)	-29.88*** (6.21)
Average Years of Schooling (male)	-	-	-	-2.81*** (0.82)
Average Years of Schooling (female)	-0.42*** (0.15)	-0.85*** (2.25)	-0.14 (0.68)	-
Natural Disaster with Death Toll Greater than 1,000	-3.32 (2.61)	-3.89 (5.09)	-23.94*** (8.70)	-14.14 (10.93)
Number of Observations	1,209	1,209	1,209	1,209
R^2	0.7167	0.7012	0.6554	0.5627
F-Stat	144.06	129.08	105.85	88.71
Robust standard errors for independent variables shown in parentheses. Years are controlled for but, the coefficients are reported in a separate table. The symbols *, **, *** correspond to a 10%, 5%, and 1% level of significance.				

Table 3. Total Health Care Expenditures and Out of Pocket Expenditures: Year Dummies

	Infant Mortality (per 1,000 live births)	Under Five Mortality (per 1,000 live births)	Adult Female Mortality (per 1,000 adults)	Adult Male Mortality (per 1,000 adults)
2003	3.31 (2.29)	6.14* (3.74)	19.71* (10.29)	26.05** (11.64)
2004	3.95* (2.21)	7.25** (3.55)	21.55** (10.15)	24.84** (11.52)
2005	3.99* (2.13)	7.00** (3.45)	19.95** (9.82)	21.95** (11.20)
2006	4.16 (2.08)	7.31** (3.36)	19.77** (9.65)	20.26* (11.07)
2007	4.42** (2.06)	7.41** (3.30)	18.78* (9.62)	17.77 (11.08)
2008	4.24** (2.05)	6.55** (3.24)	14.52 (9.44)	14.54 (10.90)
2009	2.89 (2.09)	3.79 (3.27)	6.29 (9.58)	9.42 (11.02)
2010	3.90* (2.06)	6.83* (3.57)	10.46 (9.30)	10.40 (10.74)
2011	3.89* (2.01)	5.66* (3.13)	6.83 (9.25)	7.53 (10.69)
2012	3.95* (2.02)	5.71* (3.13)	5.23 (9.29)	5.69 (10.48)
2013	3.73* (2.02)	5.36* (3.10)	6.35 (9.18)	5.46 (10.40)
2014	3.07 (1.99)	4.32 (3.03)	5.43 (9.03)	4.35 (10.24)
2015	1.90 (1.95)	2.57 (2.97)	2.34 (8.81)	1.79 (10.09)
2016	1.02 (1.95)	1.36 (2.95)	0.27 (8.85)	-1.09 (10.12)
2017	0.36 (1.98)	0.50 (2.99)	0.10 (9.00)	-2.01 (10.22)
Robust standard errors for independent variables shown in parentheses. The symbols *, **, *** correspond to a 10%, 5%, and 1% level of significance. All values are in comparison to dropped year 2018.				

For the infant mortality regression, the R-squared value is 0.7167, indicating that the model explains 71.67% of variation in infant mortality rates. Total health care expenditures per capita were significant at the 10% level, indicating that a 1% increase in total health care spending is correlated with 0.0242 fewer infant deaths per 1,000 live births. The other variable of interest, out of pocket expenditures as a percentage of total health care spending, proved to be significant at the 1% level. The model indicated that a one percentage point increase in out-of-pocket expenditures is correlated with 0.26 more infant deaths per 1,000 live births. As expected, the increase in total health care spending would lead to lower mortality rates, likely stemming from having more resources to work with. The fact that higher out of pocket spending was associated with greater mortality rates indicates that where the spending is coming from determines what impact it will have on health outcomes. Parents are probably more likely to seek care for their children despite high out of pocket costs than they are for themselves, which could be why there is still a negative correlation between total health spending and infant mortality. A majority of the other explanatory variables were also significant at the 1% level in this regression. The model indicates that a one percentage point increase in the DTP vaccination rate should lead to 0.33 fewer deaths per 1,000 live births. This correlation makes sense because the DTP vaccine is most crucial to this age group, given that whooping cough can have devastating effects on an infected infant. An additional case of HIV per 1,000 uninfected population is correlated with 1.58 more infant deaths per 1,000 live births. Access to basic sanitation in the population is correlated with 0.25 fewer infant deaths per 1,000 live births for each additional percentage point of the population with access to basic sanitation. A one percentage point increase in annual GDP growth is expected to lead to 0.35 fewer infant deaths per 1,000 live births. Additionally, a 1% increase in GNI per capita is correlated with 0.0509 fewer deaths per

1,000 live births. Additionally, the average years of education for the female population was added to this regression to align with the literature's evidence of its explanatory power in child mortality rates. The argument for this is that the mother is likely the one taking the most care of the child, making it reasonable that she will be making the most significant decisions about the child's health. The results showed that each additional year of education was correlated with 0.42 fewer deaths per 1,000 live births.

The second regression focused on under-five mortality rates per 1,000 live births. This model used the same variables as the first model and resulted in an R-squared value of 0.7012, indicating the model explains 70.12% of variation in under-five mortality rates. In this regression, total health care expenditures per capita did not turn out to be significant. Out of pocket expenditures, however, were seen to be significant at the 1% level. The regression results indicated that a one percentage point increase in out-of-pocket expenditures is correlated with 0.38 more under-five deaths per 1,000 live births. It was surprising that total health care expenditures were not significant in this regression as a decrease in mortality rates was expected to be correlated with this variable, especially considering many under-five deaths in are due to causes that are preventable with access to affordable treatment options. It is possible that this is because in many of these countries these treatments may not be affordable to the general population. The out-of-pocket expenditure variable does still lead to the expected increase in mortality for this group. This relationship again backs up the argument that it isn't just spending that matters, but rather where the spending is coming from. Parents are probably less likely to seek care for their children when they have to pay a significant portion of it, ultimately leading to a larger mortality rate. The model also sees the same additional variables significant at the 1% level as the previous regression. A one percentage point increase in DTP immunization rate

lowered under-five mortality by 0.47 deaths per 1,000 live births, which makes sense given that the DTP vaccine protects against illnesses that are most deadly to this younger population. An increase of one case of HIV per 1,000 uninfected population was correlated with 3.61 more deaths per 1,000 live births. A one percentage point increase in access to basic sanitation lowered deaths by 0.45 per 1,000 live births. A one percentage point increase in annual GDP growth was correlated with 0.35 fewer deaths per 1,000 live births. GNI per capita had a negative correlation with under five mortality, leading to 0.0822 fewer under-five deaths per 1,000 live births for a 1% increase in GNI per capita. Each additional year of female schooling also lowered under-five deaths per 1,000 live births by 0.85 in this model. These results are consistent with the literature and expected results.

The adult female mortality regression had an R-squared value of 0.6554, meaning the model explains 65.54% of variation in adult female mortality rates. Total health care expenditures were significant at the 10% level but indicated a positive relationship, with a 1% increase leading to 0.0969 more deaths per 1,000 adult females. This result is surprising but could be explained by a number of factors. There is the potential that in these developing countries, many of these adults are experiencing conditions that are not easily treated and still lead to poor outcomes in most cases despite treatment. Ailments like this will be more prominent amongst an older population. This could be conditions like cancers or HIV which are manageable to some extent in countries with decently developed health care systems, but not as much in countries with less developed health care systems like many in the sample. Ultimately this could lead to larger expenditures to try to treat conditions that will ultimately have poor outcomes regardless of health care spending. Another argument is that higher spending could be correlated with more expensive and riskier procedures or perhaps even newer drugs. These

procedures could be at higher risk of complications that result in poor outcomes and these newer, more expensive, and less tested drugs could be a greater risk for adverse reactions. In this way greater health spending could be associated with a higher level of care, but also at the same time associated with higher risk factors that could lead to higher mortality rates as a consequence. The fact that this correlation was positive while the same variable had a negative correlation with infant mortality is likely the results of parents being more likely to seek out health care for themselves than their children. At a 1% level of significance, a one percentage point increase in out-of-pocket expenditures results in 0.57 more deaths per 1,000 adult females. This continues to support the argument of the importance of where health care funding is coming from. As has been previously noted, when the consumer is responsible for paying a greater amount of the price of care, it will take something more serious for them to seek out care. Ultimately this will lead to less preventative care and poorer health outcomes. The immunization rate of DTP is no longer significant in this population, likely because it is a childhood vaccine and not completely reflective of vaccination rates across a country like had been intended. HIV incidence is still significant at the 1% level, where one more case of HIV per 1,000 uninfected population was correlated with an increase in adult female mortality rates of 15.84 additional deaths per 1,000 adult females. Tuberculosis incidence is also significant at the 1% level, indicating an increase in adult female mortality rates of 0.08 more deaths per 1,000 adult females for each additional case of tuberculosis per 100,000 uninfected population. At the 1% level of significance, a one percentage point increase in access to basic sanitation lowers mortality rates by 1.46 deaths per 1,000 adult females, while at the 10% level, a one percentage point increase in annual GDP growth lowers adult female mortality rates by 1.94 deaths per 1,000 adult females. A 1% increase in GNI per capita is also associated with a decrease in adult female mortality rates of

0.2288 deaths per 1,000 adult females. One unexpected result came from the natural disaster control dummy. The occurrence of a natural disaster with a death toll greater than 1,000 was correlated with 23.94 fewer deaths per 1,000 adult females at the 1% level of significance. This could be a result of failure to set the cutoff of the death toll for the natural disasters at a high enough level, or potentially this could be picking up on positive effects of additional relief care from greater resources being provided to the area in a time of natural disaster.

The adult male mortality regression had an R-squared value of 0.5627, meaning the model explains 56.27% of variation in adult male mortality rates. Total health care expenditures were significant at the 1% level, indicating a positive relationship, with a 1% increase leading to 0.1698 more deaths per 1,000 adult males. This is the same correlation seen with adult female mortality rates and is likely explained by a similar reason. At a 1% level of significance, a one percentage point increase in out-of-pocket expenditures resulted in an increase in adult male mortality rates of 0.44 more deaths per 1,000 adult males. This again supports the argument in favor of the importance of the origin of health spending. Immunization rate of DTP is significant at the 1% level in this population, which oddly enough saw that a one percentage point increase was correlated with an increase in adult male mortality rates of 0.63 additional deaths per 1,000 adult males. This is likely due to the fact that the vaccine chosen is not as representative of the overall vaccine environment as hoped, given that the vaccine chosen is most relevant to the younger population. HIV incidence is still significant at the 1% level and correlated with 13.83 additional deaths per 1,000 adult males for each additional case per 1,000 uninfected population. Tuberculosis incidence is also significant at the 1% level, indicating a 0.14 additional deaths per 1,000 adult males for each additional case per 100,000 uninfected population. At the 1% level of significance, a one percentage point increase in access to basic sanitation lowers adult male

mortality rates by 0.77 deaths per 1,000 adult males, while at the 10% level of significance, a one percentage point increase in annual GDP growth lowers adult male mortality rates by 0.95 deaths per 1,000 adult males. A 1% increase in GNI per capita is also associated with 0.2988 fewer deaths before age 60 per 1,000 alive at age 15 for the male population. This makes sense that greater resources from higher GDP in a nation and greater average income both had the anticipated impact of lower mortality rates. Additionally, average year of schooling for males was significant at the 1% level, where an additional year of schooling was associated with 2.81 fewer deaths per 1,000 adult males. These results all align with the literature as more educated individuals are more likely to seek out health care and make better more informed decisions about their health. This of course would lead to better health outcomes.

Public Spending Per Capita and Private Spending Per Capita

The next set of regressions focused on the origin of health care expenditures, whether private or public, to investigate their impact on mortality rates. To do this, 4 additional regressions were run, changing the two main variables of interest to the natural log of public spending per capita and the natural log of private spending per capita.

Table 4. Public Spending Per Capita and Private Spending Per Capita Regression Results

	Infant Mortality (per 1,000 live births)	Under Five Mortality (per 1,000 live births)	Adult Female Mortality (per 1,000 adults)	Adult Male Mortality (per 1,000 adults)
Constant	102.30*** (7.55)	159.07*** (12.45)	311.35*** (32.98)	358.09*** (38.23)
ln(Private Health Care Expenditures per capita)	5.00*** (0.95)	8.76*** (1.55)	26.02*** (4.50)	25.37*** (4.70)
ln(Public Health Care Expenditures per capita)	-9.04*** (0.66)	-12.88*** (1.06)	-16.44*** (2.93)	-7.87** (3.14)
DTP Immunization Rate (%)	-0.29*** (0.05)	-0.41*** (0.07)	0.26 (0.21)	0.69*** (0.23)
Incidence of HIV	1.09*** (0.33)	2.92*** (0.58)	14.70*** (0.20)	13.43*** (2.32)
Incidence of Tuberculosis	0.001 (0.003)	-0.009* (0.005)	0.08*** (0.02)	0.13*** (0.02)
Access to Basic Sanitation	-0.20*** (0.02)	-0.38*** (0.04)	-1.33*** (0.12)	-0.68*** (0.11)
Access to Basic Drinking Water	-0.08 (0.07)	-0.20* (0.11)	-0.32 (0.30)	-0.28 (0.29)
Annual GDP Growth (%)	-0.32*** (.12)	-0.67*** (0.19)	-1.89*** (0.46)	-0.93* (0.50)
ln(GNI per capita)	-1.10 (1.21)	-2.46 (2.00)	-15.71*** (5.54)	-25.37*** (6.27)
Average Years of Schooling (male)	-	-	-	-2.77*** (0.80)
Average Years of Schooling (female)	-0.46*** (0.14)	-0.89*** (0.22)	-0.18 (0.65)	-
Natural Disaster with Death Toll Greater than 1,000	-3.61 (2.37)	-4.34 (4.72)	-24.90*** (8.10)	-14.90 (10.73)
Number of Observations	1,209	1,209	1,209	1,209
R^2	0.7339	0.7178	0.6721	0.5754
F-Stat	159.94	140.30	119.63	107.17
Robust standard errors for independent variables shown in parentheses. Years are controlled for, but the coefficients are reported in a separate table. The symbols *, **, *** correspond to a 10%, 5%, and 1% level of significance.				

Table 5. Public Spending Per Capita and Private Spending Per Capita: Year Dummies

	Infant Mortality (per 1,000 live births)	Under Five Mortality (per 1,000 live births)	Adult Female Mortality (per 1,000 adults)	Adult Male Mortality (per 1,000 adults)
2003	6.00*** (2.25)	10.00*** (3.49)	24.34** (10.17)	28.50** (11.58)
2004	5.97*** (2.15)	10.15*** (3.49)	24.95** (9.99)	26.76** (11.46)
2005	5.76*** (2.08)	9.55*** (3.38)	22.86** (9.60)	23.65** (11.08)
2006	5.38*** (2.03)	9.09*** (3.28)	21.84** (9.40)	21.63** (10.91)
2007	5.38*** (1.98)	8.81*** (3.19)	20.17** (9.31)	18.79* (10.86)
2008	4.91** (1.97)	7.55** (3.13)	15.30* (9.11)	15.26 (10.67)
2009	3.46* (2.00)	4.64 (3.15)	7.12 (9.20)	10.23 (10.71)
2010	4.28** (1.97)	7.41** (3.42)	10.88 (8.94)	10.94 (10.47)
2011	4.29** (1.96)	6.27** (3.05)	7.23 (8.93)	8.07 (10.41)
2012	4.00** (1.96)	5.78* (3.03)	4.71 (9.04)	5.49 (10.29)
2013	3.66* (1.96)	5.30* (3.03)	5.97 (8.93)	5.55 (10.19)
2014	3.03 (1.93)	4.29 (2.94)	5.26 (8.78)	4.53 (10.03)
2015	1.90 (1.88)	2.57 (2.86)	2.16 (8.51)	1.74 (9.84)
2016	1.24 (1.89)	1.67 (2.88)	0.69 (8.56)	-0.77 (9.89)
2017	0.63 (1.96)	0.91 (2.95)	0.72 (8.69)	-1.51 (10.00)
Robust standard errors for independent variables shown in parentheses. The symbols *, **, *** correspond to a 10%, 5%, and 1% level of significance. All values are in comparison to dropped year 2018.				

The most important aspect of these regressions is the behavior of the public and private health care expenditure variables. For infant mortality both variables are significant at the 1%

level. The results indicated that a 1% increase in private health spending is correlated with 0.0500 more deaths per 1,000 live births. Conversely, the results show that a 1% increase in public health care spending is correlating with 0.0904 fewer death per 1,000 live births. These trends hold up across all four mortality rates. For under-five mortality both variables are again significant at the 1% level. A 1% increase in private health care expenditures is associated with 0.0876 more under-five deaths per 1,000 live births. A 1% increase in public health care expenditures is correlated with 0.1288 fewer under-five deaths per 1,000 live births in this model. Adult female mortality rates also see these two variables being significant at the 1% level. In this model, a 1% increase in private health care expenditures is associated with a 0.2602 more deaths per 1,000 adult females. A 1% increase in public health care expenditures, however, is correlated with decreasing the adult female mortality rate by 0.1644 deaths per 1,000 adult females. The final regression was run using adult male mortality rates as the dependent variable. Private health care expenditures were found to be significant at the 1% level, and ultimately indicated that a 1% increase in private health care expenditures was correlated with increasing adult male mortality by 0.2537 deaths per 1,000 adult males. Public health care spending, however, was only found to be significant at the 5% level. The outcome indicated that a 1% increase in public health care expenditures was correlated with 0.0787 fewer deaths per 1,000 adult males.

These results have interesting implications for this model. It is important to note that the same trends held across all four mortality rates that were investigated. Increased public health care spending resulted in lower mortality rates, while increased private health care spending led to higher mortality rates. Public spending is likely to have this negative correlation with mortality rates because money coming from public resources is going to lead to greater health

resources. The money that the country invests is going to be able be spent in areas that will benefit the population as a whole by way of vaccines, better medical equipment, and better medicines. All of these things can lead to a greater likelihood of good outcomes that will lower mortality rates across the entire population. The interesting result in this study was that private expenditures were associated with higher mortality rates. This may seem very strange at first but thinking back to the trend seen with higher out-of-pocket expenditures could explain much of this. The previous regressions supported the narrative that when the percentage of health care spending that came from out of pocket was higher, mortality rates were also higher. This was explained by the fact that when people were held responsible for paying for a larger portion of health care, they would be less likely to seek out that care whether they needed it or not. While the private expenditure variable also factored in private insurance and other private sources of funding, it is important to note that not every country has a system that allows for private insurances. In fact, when looking at the monetary variables, in the case of some countries in the sample, private health care spending came entirely out-of-pocket with none of this private spending coming from private insurance of any other private organization. As a result, this variable may not be telling the whole story in this regression. Rather, it is likely that the resulting correlation is being swayed by these countries whose entire private spending market comes directly out of the consumer's pocket.

The overall regression results showed very similar trends in the control variables as the first four regressions run. These variables showed many of the same levels of significance, as well as the same directional trends, and very similar coefficient values. There are, however, a few key differences to be noted. Access to basic drinking water is now significant at the 10% level for under-five mortality, where a one percentage point increase in the population with

access to drinking water is correlated with 0.20 fewer deaths per 1,000 live births. For adult female mortality rates, annual GDP growth becomes significant at the 1% level as opposed to the 10% level seen in the previous regressions. Additionally, GNI per capita is no longer significant in explaining infant mortality or under-five mortality in these models.

These results don't really support the hypothesis that increasing health expenditures lowers mortality rates in developing countries. The second set of regressions, as well at the out-of-pocket variable from the first regression, seem to indicate that the origin of the health expenditures has a much greater impact on mortality rates. The impact of the total health care expenditures, as a result, will be indicated primarily by where the money is coming from, and the model also indicates that additional spending, regardless of origin, may lead to more positive outcomes for the two younger populations investigated. Based on these results, it seems that more spending by the government on health care may in fact improve health in the population by lowering mortality rates. However, based on the private expenditure and out of pocket variables, it seems that the more money required from private sources, primarily those that come directly from the consumer, are more likely to lead to less desirable outcomes and a higher mortality rate. This is likely because some people may not have the resources to pay for medical care they need, and potentially the need to pay large amount of money for medical care could discourage those who need the care from seeking it out. It is also possible that having to pay out of pocket for much of their medical care could discourage routine preventative care as well. Ultimately this could result in only finally going to get care when a medical problem has progressed to something much more serious which may come at a higher cost to treat and may have less ability to be treated at that point.

Conclusion

Based on these results, there is enough evidence to conclude that health care spending does have an impact on mortality rates, but it is not as simple as raising the amount of money contributed to health care. It is more important to focus on where the money is coming from to determine the effect this money will have on mortality rates. The results do seem to support the idea that increasing public health care expenditures has much greater effect on lowering mortality rates in developing countries than private expenditures do. This could be due to what is causing these high mortality rates. Many of these are preventable communicable diseases that can be cut down on a larger scale by government health spending. Further research is warranted to figure out how exactly these results can used to implement policies that will further improve health outcomes in developing nations.

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Appendix

Table 6. Description of Variables

	Description	Mean	Standard Deviation	Minimum	Maximum
Infant Mortality[1]	Number of deaths before a child's first birthday per 1,000 live births	34.91	24.37	2.6	131.2
Under Five Mortality[1]	Number of deaths between the ages of one and five per 1,000 live births	48.25	38.83	3.4	210.3
Adult Female Mortality[1]	Number of deaths before age 60 per 1,000 females alive at age 15	173.64	103.01	42.15	567.53
Adult Male Mortality[1]	Number of deaths before age 60 per 1,000 males alive at age 15	245.60	102.49	67.46	663.89
Total Health Care Expenditures per capita[1]	Total expenditures on health care per capita including both public and private financing sources including health care goods and services consumed in a year	229.52	239.83	7.82	1,622.60
Private Health Care Expenditures per capita[1]	Private expenditures on health per capita including funds from households, corporations and non-profit organizations measured in 2018 US$	97.37	101.57	2.51	635.33
Public Health Care Expenditures per capita[1]	Public expenditure on health from domestic sources per capita measured in 2018 US$	122.79	157.64	0.48	1,082.50
Out of Pocket Health Expenditures (% of Total Expenditures)[1]	Percentage of total current health expenditures coming directly out-of-pocket by households	40.26	19.42	2.99	84.35
DTP Immunization Rate (%)[1]	Percentage of children ages 12-23 months who received DPT vaccinations protecting against diphtheria, pertussis, and tetanus	86.55	13.32	23	99
Incidence of HIV[1]	Number of new HIV infections per 1,000 uninfected population in the previous year	0.98	2.41	0.01	18.21
Incidence of Tuberculosis[1]	Estimated number of new and relapse tuberculosis cases arising in a given year per 100,000 population	187.68	227.27	1.9	1590
Access to Basic Sanitation[1]	The percentage of people living in households that have a handwashing facility with soap and water available	61.57	29.07	3.75	99.58

Access to Basic Drinking Water[1]	The percentage of people in a country using at least basic water services	79.92	18.03	22.93	100
Annual GDP Growth (%)[1]	Annual growth of GDP in a nation measured as a percentage to GDP	4.59	3.97	-36.39	34.47
GNI per capita[1]	Gross national income (GNI) per capita converted to 2018 US$	3712.87	3259.18	150.11	16,370.00
Average Years of Schooling (male)[1]	Average number of years of education received by males ages 25 and older	7.41	2.65	1.76	13.1
Average Years of Schooling (female)[1]	Average number of years of education received by females ages 25 and older	6.98	3.39	0.62	13.5
Natural Disaster Event[2]	Natural disaster event occurring in a year with a death toll of at least 1,000	0.03	0.17	0	1
Private Spending: Out of Pocket Expenditures[1]	Share of private health spending coming directly out of pocket measured in 2018 US$	77.38	80.38	2.05	420.78
Private Spending: Excluding Out of Pocket Expenditures[1]	Private health spending excluding all out-of-pocket payments measured in 2018 US$	19.99	40.33	0	298.09
Sources: [1] The World Bank World Development Indicators, [2] EM-DAT Database					