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The effects of public and private health spending on under-five mortality: Do female literacy and good governance matter?

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Abstract: This paper sought to investigate the effects of total, public, and private health expenditure on under-five mortality rates (U5MRs). The study is carried out using simultaneous equation models in a sample of 73 Asian and African countries spanning the period 1995-2023. Findings showed that total and public health expenditures are likely to reduce under-five mortality rates in both African and Asian regions. Whereas private health spending was found to be insignificantly related to child deaths in most cases of estimation. Estimation demonstrate also that female literacy and the quality of institutions play a significant role in mediating the relationship between health spending and U5MRs. Moreover, the study also showed that improvements in water sanitation, physicians' density, and GDP growth all work together to decrease the plausibility of U5MRs. From a policy standpoint, the study calls for health policymakers in African and Asian regions to increase the proportion of their annual budgets to healthcare as a strategy to reduce U5MRs.

Keywords: *Asian and African countries, Female literacy, Governance, Health spending, Infant mortality.*

1. Introduction

In the last few decades, infant health has attracted the attention of various stakeholders, including policymakers and researchers. Combating this scourge is considered a key policy objective and strategy. International organizations, such as the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the World Bank, have incorporated the objective of decreasing child mortality into most of their programs in the future. Recent statistics provided by UNICEF in 2022 showed that there were approximately 4.9 million under-five deaths, and four million occurred in South Asia and Sub-Saharan Africa, which represent 80 percent of child deaths worldwide. This translates to about 13.400 children dying every day before reaching 5 years. Despite the remarkable progress made in the world in child survival in the last few decades, the number of child deaths is still significant, especially in developing regions like Africa and South Asia. Although these regions have achieved remarkable improvement in child survival rates since the adoption of the Millennium Development Goals (MDGs), infant deaths continue to be the highest among all regions. Various factors are considered responsible for the high rate of infant mortality in these countries. Recent research documented that globally, maternal health, quality and access to medical care, and public health practices, infectious diseases remain the most commonly sighted factors leading cause of infant deaths.

Today, the fight against this scourge is considered one of the key policy objectives. For that reason, decreasing the burden of deaths and morbidity is widely regarded as one of the foremost health challenges in the world and has become a major concern of international organizations, as was reflected in Millennium Development Goal 4. Academic scholars linked to the subject opinion that, among factors that could explain the underlying high under-five deaths around the world, have found several upstream factors, including female literacy and quality of governance. At the same time, countries have prioritized policies on health spending and education in view of the fact that countries with high rates of health

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expenditures and better education are those that have succeeded in reducing their infant mortality rates. Health economic theory predicts that government spending reduces mortality rates because it is fundamental to the ability of health systems to improve human welfare. In addition, recent research also suggests that female education is a strong force influencing childhood health status. Health economics theory opinion that a mother's comprehension of health conditions directly impacts her unborn child before conception, during pregnancy, and during the formative years. Indeed, an educated mother may interact well with medical personnel, suitable health decisions for her children and apply specific knowledge about health and nutritional practices that promote child health. In this context, the United Nations study conducted during the 1980s and the World Fertility Survey (WFS) program showed that a better women's education was linked with a greater probability of infant survival in a wide range, especially in developing countries. In addition, we suppose hygiene and living conditions, health indicators, and socio-economic factors to be significant influences on studied mortalities as well, all described later in this paper.

It is within this framework that our research is conducted. It seeks to examine the impact of health expenditure on infant mortality taking into consideration the mediating role of both good governance and the level of female literacy. The interest of this study comes from the fact that very few works are interested, in a simultaneous way, in these four elements. From our knowledge, this is the first work investigating the association between private and public health spending, female education, good governance, and under-five mortality. Good governance and education remain an important channel through which health spending affects child health status. A higher level of maternal education affects the child's health and reduces the probability of death. We think that if several studies have been made to examine the governance and education impacts in mediating the health spending-childhood health relationship. To our knowledge, no empirical study has examined the issue of the threshold effect between private and health spending and infant mortality. Using aggregate data from 73 developing countries between 1995 and 2022, this study disentangles the link between health spending, female literacy, good governance, and child health. More specifically, the paper aims to examine how health spending and a country's governance regime status and maternal education, respectively, affect under-five mortality. The paper also seeks to break health spending down into its public and private components to examine their impacts on under-five mortality rates. Making such an analysis is important because it will afford a better understanding of the effectiveness of health spending on childhood health. Furthermore, results may be vital to the policymakers by helping them to determine appropriate policy interventions to ensure that infant health care is improved. Based on these considerations, this study stains to answer the following question: What are the impacts of private and public health spending on under-five children mortality? Would the quality of governance and female education may help developing countries such Asian and African ones to reduce infant mortality rates?

Following this introduction, the rest of the paper is organized as follows: Review of related literature (Section 2), empirical methodology (Section 3), results and discussions (Section 4) and concluding remarks (Section 5).

2. Literature Review

The empirical evidence regarding the links between health expenditure and health status is largely discussed in the last few decades. The empirical results are varied depending on the methodologies and examined periods. Some of these works have shown that health expenditures have a positive effect on child mortality [1] others report a negative impact [2] and a third group finds the impact to be ambiguous and conflicting [3].

For instance, using the simultaneous equations model for a sample composed of 73 countries spanning the period 1995-2012, Dhrifi [4] investigated the relationship between public and private health spending and child deaths. Results showed a positive impact of health spending on child mortality for upper-middle- and high-income countries; however, for low- and lower-middle-income ones, health spending has no significant impact on infant health status. Results also revealed that

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private health spending has a greater impact on U5M for more developed countries than public health spending; however, for less developed countries, public health expenditure has a positive effect on under-five mortalities than private expenditure. Using panel data for 25 countries over the 2000-2015 period, Raeesi, et al. [5] investigated the private and public health spending on four health indicators used in the study. Findings showed a significant link between health spending and health indicators, including infant mortality. The authors conclude that policymakers should focus on the factors that lie within the health care sector.

In the main vein of studies, Sibanda, et al. [6] investigated the possible linkages between health spending, quality of institutions, and under-5 deaths in 46 sub-Saharan African countries. The authors used data for the period 2000 -2021 and employed a systems GMM estimator. Results reveal that the quality of institutions has a moderating role in the health-spending and child mortality relationship. For the same objective, Houeninvo [7] used panel data and the GMM estimator method for 37 African countries spanning 1995–2018. Findings demonstrated that the level of public spending has a beneficial impact on mortality rates. Moreover, using a balanced panel of data from 20 low-income countries in the Sub-Saharan Africa region, Ayipe and Tanko [8] showed that for every additional percentage increase in government health expenditure, it is likely to result in approximately 5.3 units decrease in U5M rate. Kaushalendra, et al. [9] examined the same topic for the case of India. Using fixed effect regression, findings showed that public expenditure on health has a marginal effect of −0·077 on infant mortality and −0·126 on under-five deaths. Results also documented that female literacy and age at the birth of the children are considered significant determinants of under-five and infant mortality. Similarly, Barenberg, et al. [10] examined the impact of health spending on infant mortality in India, authors confirmed that a rise in public health spending by one point is connected with the U5M declining by about eight deaths of infants per 1000 live births. The results of Arthur and Oaikhenan [11] corroborate the above study since public expenditure had a declining impact on infant mortality in Africa. While private spending had an increasing effect.

Sultana, et al. [12] employed a (VARX) model to examine the effects of health expenditure on health outcomes in Bangladesh during the period 1990-2019. Their findings revealed that the per capita health expenditure and the number of doctors showed a positive impact especially on maternal and child health.

Another set of empirical works documented that government health spending did not improve childhood mortality. Akinlo and Sulola [13] examined the impact of health spending on under-five mortality in ten African countries spanning the 2000–2008 period. Their findings showed that health spending has not been translated into improvement in infant mortality in the selected African countries. The authors concluded that this may be due to the weakness of institutions and corruption in sub-Saharan African countries.Zhou, et al. [14] using (FMOLS) method and data spanning the period 2001-2020 showed that public health expenditure was health expenditure was found to be directly related to infant mortality in the Economic Community of West African States (ECOWAS). Using (ARDL) technique [15] tested the effects of health spending on infant mortality rates in Nigeria during the period of 1992 -2023, their findings showed a negative but statistically insignificant impact on infant mortality suggesting that health expenditure has a weak impact on reducing infant mortality rates in Nigeria. Dhrifi [16] examined the effect of public health expenditure on infant health outcomes, taking into account the role that institutional quality can play. The author uses a two-step system dynamic GMM method for 93 countries during the 1995–2015 period. Their findings showed that there is a certain threshold that countries must reach for health spending (% of GDP) to have a positive impact on child mortality rates. This level is estimated at around 7%.

It can be observed from this empirical literature that results vary between country groups and variables and differences depend on data types and methods of estimation. These divergences in findings suggest that it would be worthwhile to clarify these relationships in 73 selected Asian and African economies. After reviewing the findings of previous literature on this topic, the following section will

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explain the methodology, including the model specification, the sample choice, the selection of variables, and the sources of data.

3. Empirical Methodology

This section specifies the model used to empirically investigate the under-five mortality effects of health expenditure, taking into account the role played by female literacy and governance. It also provides a simple description of the data set used in the empirical investigation.

3.1. The Model

The broad objective of this paper is to examine the interrelationship between private/public health expenditures, education, and institutional quality on childhood mortality. Economic literature shows that the three variables are interlinked: infant mortality on government expenditure. It is established that female education is the most important factor that plays a leading role in the process of childhood health status. It is also shown that education depends on government expenditure. So, it is worth investigating the interlinks among these variables by considering them simultaneously in the same modeling framework. To empirically investigate the impact of health spending on child mortality, we need a specified model that makes it possible to capture simultaneously the interactions of all interest variables namely infant mortality, health spending, female education, and governance. We think that a simultaneous equations model is considered the most appropriate for this problem because it can simultaneously test the effects and causality of all interest variables. The model's specification is consistent with those reported in the literature and makes it possible to identify the channels through which public/private health spending and other variables affect childhood health. In particular, the empirical model consists of a U5M equation, and two other equations: one for the health expenditure equation and the other for the female literacy equation.

The first endogenous variable in the model is U5M. Following the empirical health literature on the determinants of health, it is worthy to remind that it is related to a set of variables. In addition to health care expenditures, quality of governance and female literacy, the specification of the child mortality equations includes other variables, namely poverty; per capita GDP growth; water use efficiency; urbanization; and CO2 emissions, which capture the cleanliness of the environment, [4]. Drawing on the existing literature on the determinants of health expenditure (second equation), the set of explanatory variables includes per capita income (GDP); the population age structure (POPSTR), which is often included as a covariate in health expenditure regressions, physicians' density, which is defined as the number of doctors per 1,000 inhabitants and is used to account for the supply of health care, can be considered a factor behind higher health spending. As regards the female literacy equation, we include U5M, health spending, real GDP per capita, urbanization, and government spending on education. These variables have traditionally been flagged as important determinants of women's education. On this basis, we use the following simultaneous equation models to investigate the interrelationship between these variables. The complete models used in this study to examine the three-way linkages are empirically examined by making use of the following three models:

$$U5M_{it} = \lambda_0 + \lambda_1 HEXP_{\ it} + \lambda_2 FemL_{it} + \lambda_3 GDPG_{it} + \lambda_4 INST_{it} + \lambda_5 WATER_{it} + \lambda_6 POV_{it} + \lambda_7 ENV_{it} + \xi_{1it} \quad \text{(Equation 1)}$$

$$HEXP_{it} = \alpha_0 + \alpha_1 U5M_{it} + \alpha_2 FemL_{it} + \alpha_3 GDPG_{it} + \alpha_4 DocDens_{it} + \alpha_5 INST_{it} + \alpha_6 PopStr_{it} + \alpha_7 FD_{it} + \xi_{2it} \quad \text{(Equation 2)}$$

$$FemL_{it} = \beta_0 + \beta_1 Hexp_{it} + \beta_2 PSE_{it} + \beta_3 POV_{it} + \beta_4 GDPG_{it} + \beta_5 URB_{it} + \beta_6 INST_{it} + \beta_7 TecInnov_{it} + \xi_{3it} \quad \text{(Equation 3)}$$

Where i ranges from 1 to 73 representing countries; t ranges from 1 to 28 representing years; ξ_{it} represents the error terms; (U5M) represents under-five mortality (per 1,000 live births); this measures the proportion of deaths among children under five years of age. It indicates the impact of the socioeconomic situation of the mothers, their lifestyles and characteristics, and the effectiveness of

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health systems for maternal and newborn health. (HEXP) Design Health-care expenditures, captured by total per capita health expenditure, including government and private spending. FemL represents female literacy: measured by net enrollment ratio, primary, female (%). (POV) design poverty proxied by per capita consumption [4, 17]. (Water) represent access to drinking water, measured by the proportion of households that obtain water considered drinkable from a tap, or from protected wells and boreholes. (Env) is an indicator representing the quality of the environment measured by per capita CO2 emissions expressed in metric tons; it captures the cleanliness of the environment. (GDPG) represents per capita GDP growth. (DocDens): design Physician's density captured by the number of doctors per 1,000 inhabitants and is used to measure the availability of health care in a country. A larger number of doctors relative to the population indicates easier access to health care and should correlate with a lower mortality rate. (INST) is an indicator representing the quality of institutions included in the three models to capture the quality of governance. It is measured by the rules of law provided by the International Country Risk Guide. (PSE) design public spending on education. (URB) represents the percentage of urbanization in a country. (TEC) is a variable that measures the technological innovation captured by the internet users per 1000 inhabitants.

Table 1, presented below, summarizes the variables and the considered data in our model. The table also reported the sign of the expected coefficients of the explanatory variables.

Table 1.
Definition of variables, data sources and expected signs.

Variables	Descriptions	Sources	Expected signs		
			Eq.(1)	Eq.(2)	Eq.(3)
U5M	U5M per 1,000 live births, number of children dying before reaching age five	WDI		-	
Hexp	total per capita health expenditure, including government and private spending	WDI	-		+/-
FemL	Growth of GDP per capita	WDI	-	+	
INST	Institutions: Law and Order	WGI	-		
POV	Poverty: Households final consumption expenditure per capita		+		+
Water	proportion of households that obtain water considered drinkable from a tap, or from protected wells and boreholes	WDI	+		
CO2	Carbon dioxide emissions (metric tons per capita)	WDI	+		
GDPG	Growth of GDP per capita	WDI	-	+	
URB	Urbanization (% urban population of total population)	WDI	-		
DocDens	number of doctors per 1,000 inhabitants	WDI		+	
PopStr	proportion of young (those aged under 15) and older people (aged over 65 or 75) in the active or total population	WDI		+	
FD	Financial Development: (total credit to the private sector %GDP)	WDI		+	
T*ecInnov*	number of internet users per 1000 habitant	WDI			+
PSE	Public spending on education % GDP	WDI			+

Note: the signs (+) and (−) correspond respectively to the expected positive and negative effect.

3.2. Estimation Strategy

As mentioned above, this study uses SEMs to test the three-way linkage between U5M, health spending and female literacy. This technique is generally used when an endogenous variable in one equation becomes a control variable in another. Estimation techniques that may be adopted in the context of EMs depend on identification criteria for estimating the model and the endogeneity problem. In this work, our model is overidentified, having an endogeneity problem, which is why estimation by ordinary least squares would be double-registered. This method is based on the three-stage least squares (3SLS). In this study, we will use three measures of health expenditures, namely global, public, and private health spending. We expect that global, private, and public health expenditures reduce the under-five mortality rates.

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3.3. Data and Descriptive Statistics

Summary descriptive statistics of the interest variables used in the empirical analyses are provided in Table 2. We notice that on average, the highest level of under-five mortality is found in African regions. The under-five mortality rate in Africa averaged 89.1 per 1,000 live births during the studied period, ranging from a minimum of 39.1 per 1,000 live births to a maximum of 129.6 per 1,000 live births (see figure 1). Regarding the Asian region, the average under-five mortality is about 63.67 per 1000 live births, ranging from a minimum of 25.3 to a maximum of 106.7 per 1000 live births. This variable exhibits the greatest variability in the case of the African region. If we consider, global health expenditures- the second interesting variable in this study- statistics show that on average, global healthcare expenditures were estimated to be about 4% and 5% of GDP, in Asia and Africa respectively. Figure 2 highlights the trend of health care expenditure in the different regions worldwide. Against the North American region, Asian and African regions display the lowest rates of health expenditures with about 4 and 5 percent respectively. The world average is about 10 percent for selected years. It is noticed that although global health spending increased over the years in the two considered regions, it is still far below the North American (more than 15%) and the world's health government spending trends. The condition of public health spending (% government expenditure) is very poor in African and Asian economies. It is around half of that of the world's average health government spending and less than one-third of that of North America. Fig.3 below highlights the female literacy trends by region. Statistics revealed that on average Sub-Saharan Africa displays the lowest female literacy rates among all regions (52.23) followed by South Asian countries (52.63). It ranges from a minimum of 45.21 and a maximum of 61.43 in South Asia and from 36.32 to 66.85 in Sub-Saharan African countries.

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Table 2.
Descriptive statistics by panels of countries.

Region		U5M	Hexp	FemL	GDPG	Urb	PopStr	Water.	CO2	FD	POV	Doc Dens	Inst.	TEC	PSE
	Min.	25.3	2.31	36.32	-5.67	44.87	0.00	0.051	0.12	83.48	0.31	0.04	0.00	0.00	4.62
	Max.	106..7	6.37	66.85	7.62	96.64	5.36	0.85	44.36	31.64	9.54	1	1	5.23	7.64
Asia	Mean	63.67	4.83	52.92	3.95	61.27	0.87	0.65	5.92	83.48	4.31	0.59	0.53	0.45	5.62
	St. Dev.	27.61	0.94	0.96	2.69	8.64	0.64	0.55	3.96	31.64	0.68	0.33	0.51	0.23	1.64
	Min.	39.1	2.65	45.21	-4.58	41.87	0.00	0.039	0.17	83.48	0.38	0.04	0.00	0.00	3.62
	Max.	129.6	5.97	61.43	6.61	89.64	4.92	0.79	49.81	31.64	10.54	0.99	1	5.62	6.64
Africa	Mean	89.1	3.12	52.69	3.052	57.18	0.81	0.67	4.25	67.43	5.44	0.49	0.48	0.42	3.89
	Std. Dev.	5.57	0.86	8.03	2.72	7.51	0.51	0.52	4.09	7.38	0.59	0.283	0.58	0.084	1.70

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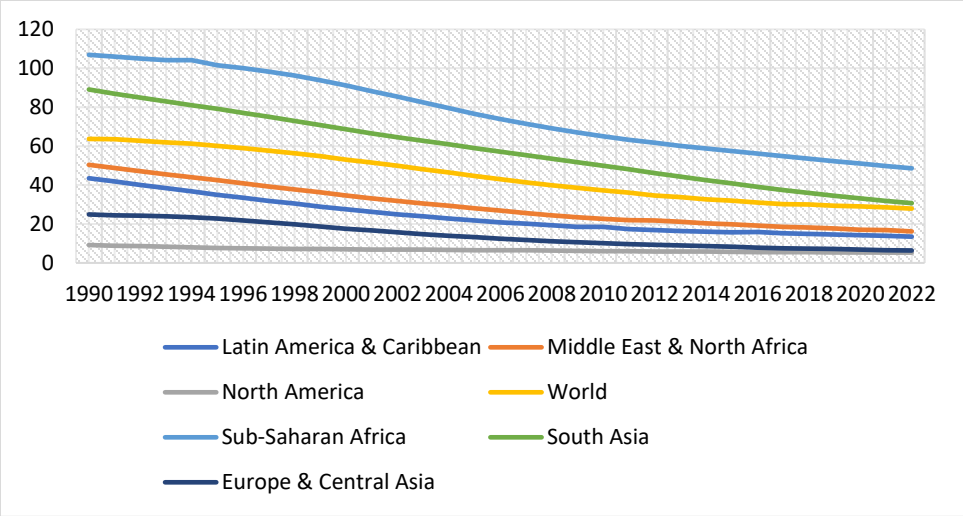

Figure 1.
Infant mortality (%GDP) by region.

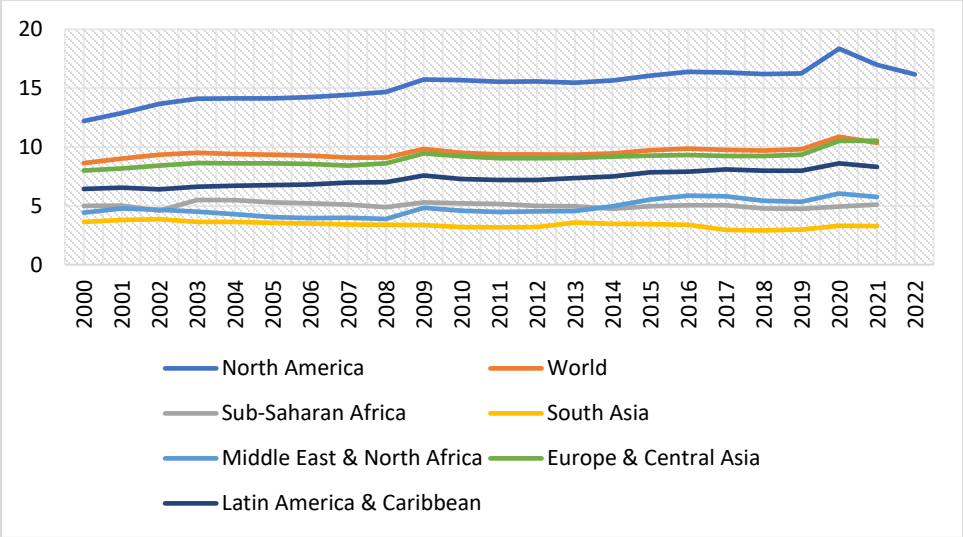

Figure 2.
Health Expenditure (% GDP) by region.

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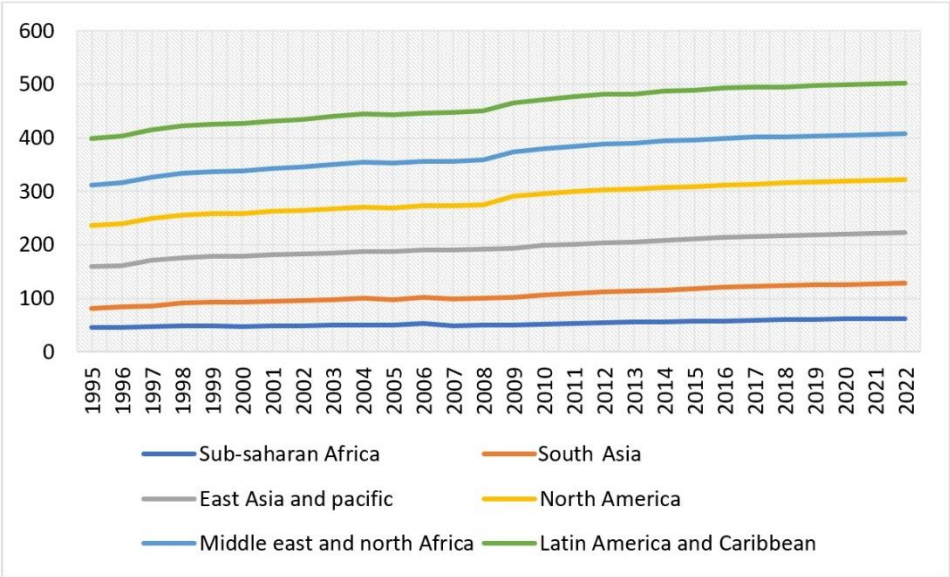

Figure 3.
Plots of female literacy total, 15+ by region

4. Main Results and Discussion

4.1. Baseline Results

In the present section, we present the regression results for our estimable models. Table 3 reports the estimated results for the global panel of 73 countries, including countries from Africa and Asia over the period 1995-2023. The first row of the table displayed the results for the under-five mortality equation, in which the parameters of interest are the coefficient that represents the effect of total health spending and female literacy on infant mortality. The estimated coefficient on health expenditures shows a negative relationship between health expenditure and infant deaths. An increase in total health expenditure was more likely to decrease under-five mortality at a 5% significance level: a 1% increase in total health expenditure leads to an improvement in child death rates by about 0.091 point. This suggests that health expenditure can be viewed as a determinant factor of infant health status. It also means that infant health status depends on the spending rate on health, which suggests that an increase in health spending implies broader access to health services, which help reduce mortality rates. Our finding corroborates other studies that found a positive relationship between health expenditure and health outcomes [4, 18]. However, our finding contradicts those found by Asim Anwar et al. 2023. Using the (GMM) method for panel data spanning the 1996-2020 period for thirty-eight OECD countries, authors found that health expenditures have a negative impact on infant mortality.

Regarding the second variable of interest, results demonstrate that female literacy has a significant effect on infant mortality: a one standard deviation increase in female literacy decreases under-five mortality by around 0.13%, and the coefficients of 0.13 indicate that one more year of women's education decreases under-five mortality by about 0.13 years, suggesting that additional women schooling drives significant improvements in childhood health status. This finding confirms the results achieved by Kaushalendra, et al. [9]. Using fixed effect regression for the case of India, the authors showed that female literacy and age at the birth of the children are considered significant determinants of under-five mortality. It also corroborates the results found by Dhrifi, et al. [19] the authors concluded that the positive effect of education on health status, in general, may be explained by the fact that better-educated people are more likely to exercise, less likely to smoke and get health check-ups; high educational attainment can improve health through work and economic conditions.

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Looking for the estimated coefficient of the institutional quality variable which consists of the third interested variable in this study, the coefficient of law and order appears to be statistically negative showing a negative relationship between the quality of institutions and child health. An improvement of the quality of governance was more likely to decrease under-five mortality at 1% significance level: a one percent increase in law and order leads to a decrease in infant mortality by about 0.72 point. Our results corroborate those found by Alireza, et al. [20] using fixed effects and (GMM) models, authors conclude that institutional quality (as measured by Rule of Law, Voice and Accountability, Control of Corruption, Political Stability, Regulatory Quality, and Government Effectiveness) reduces infant mortality rates and increase life expectancy at birth. The same results are also confirmed by Sibanda, et al. [6] using a systems GMM model for 46 sub-Saharan African countries, their findings reveal that institutional quality significantly influences the impact of health expenditures on under-five mortality. The authors concluded that the quality of governance enhances the effectiveness of health spending in improving infant health status.

Regarding the other explanatory variables introduced into the first model, they have the expected signs and are statistically significant. Particularly, the results regarding GDPG variable show a positive and significant effect on under-five mortality at the 1% level. Specifically, a 1% increase in GDP growth leads to, approximately, 0.23% fall in infant mortality rates. This result implies that increases in GDP growth allow policy makers to allocate resources to the health sector and help persons to be able to afford essential health services, especially infant health care, leading to a reduction in child mortality rates. In the case of water access, the coefficient shows that a 1 percentage point increase in this variable will decrease the under-five mortality rate by 0.61 percentage points. Regarding the estimated coefficient of poverty and in congruence with the health economic literature, results show that a 1 percentage-point reduction in the poverty rate decreases the under-five mortality rate by about 1.42 points [4]. Finally, the environment variable, as proxied by CO2 emissions, displays a coefficient of 0.4, significant at the 1% level, which means that a 1 standard deviation increase in CO2 emissions is associated with a 0.4 percentage point increase in under-five mortality. This finding is in line with the health economics theory that predicts a significant association between exposure to air pollution and adverse pregnancy outcomes, including low birth weight, small for gestational age, preterm delivery, and stillbirth.

The second row of Table 3 reports the estimation of the health-expenditure equation. As expected, the results show that under-five mortality is related positively and significantly to health expenditure. This can be explained by the fact that good health during childhood can subsequently lead to high levels of productivity, which can consequently promote economic growth, and this can increase the total government expenditures. Regarding the estimated coefficient of female literacy, it appears to be positively and statistically significant, showing a positive relationship going from women's education to health expenditure. Looking for the health spending impact of GDP growth, as expected, the results show that economic growth is positively and significantly related to government health spending. Regarding the population structure variable, the estimated coefficient appears significant at the 5% level, showing a very strong and positive correlation with health-care spending. This suggests that access to health care has a major positive impact on health spending. In terms of the health expenditures effects of physicians' density variable, results showed a positive and significant relationship between the two variables; so, a larger number of doctors per one thousand population means more accessible health care and may correlate with a lower under-five mortality rate.

In the third specification, we find a positive relationship between economic growth and women's education. The α_1 value for this equation, which measures the elasticity of female literacy with respect to healthcare spending, appears significant at a 5% level demonstrating that an increase in health spending leads to higher levels of women's education, showing that the effect of government spending on education is detrimental and favorable; education increases by about 0.86% with an increase in health expenditure by 1%. Regarding the estimated coefficient on public health spending on female literacy, it appears to be positive and significant at a 5 percent level showing that increasing women's education

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may provide the best results in terms of the labor market, household income and household welfare. Looking for the impact of infant mortality on female literacy, the relationship appears to be positive showing a positive impact of child health on women's education. This finding is in line with the health economic theory that healthy infant learns better and, as young, are better educated and more able to earn a high income [16]. In terms of female literacy impacts of poverty, the results show that poverty and female literacy are inextricably linked; A 1% decrease in poverty leads to a 1.18-year increase in women's education. This implies that poor children may stop going to school so they can work, which leaves them without literacy. For the other explanatory variables of this specification (public spending on education, technology, urbanization and institutional quality) they presented the expected signs and they are all statistically significant showing a positive impact on female education.

Table 3.
Results of the global panel.

Variables	U5M	Hexp	FemL
U5M	--	-0.226 (0.000)**	0.478 (0.055)**
Hexp	-0.091 (0.021)**	--	0.862 (0.027)**
FemL	-0.133 (0.037)**	0.433 (0.000)***	--
GDPG	-0.236 (0.004)***	0.183 (0.053)**	0.437 (0.00)***
INST	-0.725 (0.003)**	0.947 (0.000)***	0.706 (0.004)***
Water	-0.618 (0.006)***	--	--
POV	1.422 (0.035)**	--	1.187 (0.00)***
ENV	-0.405 (0.000)***	--	--
DocDens	--	0.064 (0.008)***	--
PopStr	--	0.417 (0.003)***	--
FD	--	0.0097 (0.085)*	--
PSE	--	--	2.067 (0.000)***
Urb	--	--	1.935 (0.000)***
Tec	--	--	0.031 (0.060)*
CST	4.578 (0.000)***	3.389 (0.000)***	3.351(0.000)***
Observations	2117	2117	2117
R^2	0.19	0.2	0.19

Note: * significant at 10%, ** Significant at 5%, *** Significant at 1%. The numbers reported in the brackets represent the t-statistic.

Lastly, we think that the results found in this first estimation do not seem to apply to the two regions in our considered sample, and conclusions may depend on the specific characteristics of each region. Therefore, it is so appropriate to conduct estimations on this topic with samples of countries that have broadly similar characteristics, since it would be possible to account for the specific nature of each region. We then proceed to examine the robustness analysis.

4.2. Robustness Analyses

Having examined the under-five mortality impacts of health expenditure on the global panel, we proceed with the verification of the consistency of these results. In this respect, the global panel is first segmented into different geographical regions. Table 4 presents the estimated results for the panels of the two considered regions. In both African and Asian panels, total health expenditure and infant mortality are found to be negatively related with a significance of 10% and 1%, respectively, showing that a 1% increase in health expenditures in African and Asian regions reduces mortality rates by 0.013% and 0.11%, respectively. Moreover, although the positive effect of total health expenditure is consistent for both African and Asian regions, the effect is higher across Asian countries. This implies that, although health is negatively correlated with under-five mortality, the magnitude of impact is higher within Asian countries. This result is logical since the rates of health expenditures in Africa are the lowest compared to the other regions (Figure 2 above), although most African economies have improved their budget allocated to health care over the past two decades. Our findings are consistent with those found by Filmer and Pritchett [2] using a multivariate regression, point out a very weak

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effect of government health spending on infant mortality. Similarly, Gupta, et al. [21] points out that the substantiation of the link between government health spending and health status is not strong, especially in developing countries like the African region. Moreover, the highly significant effect of health expenditure in the case of the Asian region may be due to access to basic lifesaving interventions, better access to healthcare, improved hygienic conditions, and higher living standards, which have allowed mothers in this region to experience safer child health. Our results corroborate those of the study of Polcyn, et al. [22] using the AMG and CCEMG methods of estimation for 46 Asian countries spanning the the1997-2019 period. The authors found a positive relationship between government health expenditures and health outcomes. They conclude that the more the government spends on general health services, the higher the quality of health outcomes. However, our results contradict those found by Rahman, et al. [23] using a panel data set for 15 ASEAN countries over the period 1995–2014, their results showed that an increase in total health spending was more likely to increase the death rate. Moreover, when they split the health spending into private and public, they found that only private health expenditure reduces death rate in ASEAN countries, whilst public spending raises the death rate by about 0.06 unit.

Table 4.
Estimation results of the two sub-panels.

		AFRICA				ASIA	
Variables	**U5M**	**Hexp**	**FemL**		**U5M**	**Hexp**	**FemL**
U5M	--	-0.167	-0.366		--	-0.217	-0.293
	--	(0.000)***	(0.082)*		--	(0.016)**	(0.057)**
Hexp	-0.013	--	0.893		-0.116	--	0.813
	(0.091)*	--	(0.000)**		(0.001)***	--	(0.000)**
FemL	2.08	0.0571	--		1.672	0.0367	--
	(0.026)**	(0.029)**	--		(0.034)**	(0.008)***	--
GDPG	-0.326	0.203	0.394		-0.437	0.288	0.342
	(0.022)**	(0.036)**	(0.000)***		(0.000)**	(0.001)***	(0.000)***
INST	-0.534	0.864	0.459		0.719	1.064	0.534
	(0.000)**	(0.002)***	(0.000)***		(0.000)**	(0.001)***	(0.004)***
Water	-0.982	--	--		-0.727	--	--
	(0.026)**	--	--		(0.053)**	--	--
POV	2.385	--	--		1.924	--	--
	(0.007)**	--	--		(0.039)**	--	--
ENV	0.084	--	--		0.063	--	--
	(0.002)***	--	--		(0.001)***	--	--
DocDens	--	0.729	--		--	0.729	--
	--	(0.000)**	--		--	(0.000)**	--
PopStr	--	-0.626	--		--	-0.626	--
	--	(0.000)**	--		--	(0.000)**	--
FD	--	0.081	--		--	0.081	--
	--	(0.137)	--		--	(0.137)	--
PSE	--	--	0.729		--	--	0.729
	--	--	(0.000)**		--	--	(0.000)**
URB	--	--	-0.62		--	--	-0.62
	--	--	(0.000)**		--	--	(0.000)**
TEC	--	--	0.081		--	--	0.081
	--	--	(0.237)		--	--	(0.237)
CST	7.364	5.281	4.924		8.826	3.973	5.274
	(0.003)***	(0.001)***	(0.028)**		(0.003)**	(0.001)***	(0.005)***
Observations	1261	1261	1261		841	841	841
R^2	0.21	0.19	0.19		0.2	0.18	0.19

Note: * significant at 10% ** Significant at 5%; *** Significant at 1%. The numbers reported in the brackets represent T-Student.

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4.3. Private And/Or Public Expenditure on Under-Five Mortality

This section examines the under-five mortality effects of private and public health expenditure for the case of the full sample and sub-groups. Findings reveal that public health expenditure has a significant effect on child health, whatever the groups considered. However, results indicate that private health expenditure exhibits a statistically non-significant relationship with infant mortality in the case of the whole sample, a negative impact in African countries, and a positive and weakly significant impact in selected Asian countries. We also notice that while the impact of public health spending is confirmed in the two groups of countries, the magnitude of impact is higher in African countries. The highest impact of public health spending on under-five mortality in African economies may be explained by the fact that on average, African countries devote more budget to public health spending than Asian economies (see fig.2 above) since health economic theory predicts that countries that spend more on public health care are likely to have a lower infant mortality rate. This positive effect of public health spending on infant health outcomes is consistent with several researchers including the study Rezapour, et al. [24] the authors conducted their study based on cross-sectional data during the period 2000-2015, their results showed a negative and significantly relationship between public health spending and health indicators including infant mortality in low, middle and high income countries, whereas their findings showed that private health expenditure negatively affects infant health status. . However, private spending on health has a positive impact on child and infant mortality rates only when it interacts with public health expenditure. This means that the effect of private health expenditure on infant mortality is strengthened by public health expenditure. In the same vein of studies, Dhrifi [4] showed that in developing countries, public health expenditure has a greater effect on mortality rates than private health spending, while in developed economies, private health spending has a positive effect on infant health. However, our results contradict those found by Logarajan, et al. [25] who argue that public and health spending are statistically insignificant in the case of Malaysia. using data for 15 ASEAN countries during the 1995–2014 period, Rahman, et al. [23] found that an increase in global health expenditure increases death rates. Moreover, when they split health spending into private and public, they found that only private spending decreases infant mortality in ASEAN countries.

Table 5.
Summary of under-five mortality effects of private and public spending by sub-panels.

	Private health expenditure	**Public health expenditure**
Full Sample	-0.079	-0.037
	(0.024)	(0.043)**
Africa	0.351	-0.052
	(0.178)	(0.000)***
Asia	-0.006	-0.018
	(0.073)*	(0.039)**

Note: * sig. at 10% ** Sig. at 5%; *** Significant at 1%.

We can conclude from the above that if the impact of public health expenditures on under-five mortality is largely confirmed in both African and Asian regions, the under-five mortality effects of private health expenditures are ambiguous since they appear to be statistically insignificant for most cases of estimation. This implies that public health spending is more effective than private spending, as it may improve health outcomes by creating positive external effects. Therefore, the governments must provide enough required financial resources for improving childhood health status.

5. Conclusion

This paper aims to examine the joint effects of health expenditure, female literacy, and the quality of governance on U5MRS. The study is carried out using Simultaneous equation models on a sample composed of 73 Asian and African countries over the period 1995-20222. Results revealed that, if the positive effects of total health expenditure are largely confirmed in both African and Asian regions, the

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extent of impact is higher in Asian than in African countries. When the total health expenditure was broken down into its public and private components. Results showed that only public health expenditure positively influences child mortality. For private health spending, results show no significant impact in the case of the African region and a weakly significant positive impact on child deaths in Asian countries. findings also showed that female literacy and good governance play an important role in the reduction of child deaths. Besides, other socio-economic factors like clean water, GDP growth, poverty, environmental quality, physician density, and the level of infrastructure are considered crucial for infant health outcomes.

In light of the above findings, it is recommended that policymakers in these regions should increase budgets devoted to the health sector and give more and more incentives to the private health sector as a complement to enhance the healthcare facilities and improve infant health outcomes. It is substantial to note that the private health sector is required to reduce under-5 mortalities within the considered region. it will be more beneficial to focus on increasing the number of physicians because having more physicians per 1000 populations would be the best way to enhance the child's health. In addition, establishing effective private-public partnerships to improve the healthcare system may go a long way towards reducing child deaths and improving health population outcomes [4]. African and Asian regions should also increase their spending on education, especially women's literacy because female education -as be found in our study- can be a crucial determinant of their infant health status since better-educated mothers are likely to be more conscious of their infant's health and nutrition, which will influence their infant survival chances.

Transparency:

The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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