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Key Determinants of Infant Mortality Rate in Asian Countries: A Cross-Sectional Analysis

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Abstract

Key determinants of Infant Mortality across Asian countries are examined in this study using secondary data from the World Development Indicators. By focusing on variables including access to clean water, female literacy rate, health expenditure, immunisation of children, and per capita GDP, the study employs an OLS regression framework for 41 countries. Regression results reveal that improving water accessibility is the most influential factor, followed by a higher literacy rate among females, where a one-unit increase reduces IMR by 0.31 ($p < 0.01$), indicating its strong explanatory power Health expenditure and child immunisation coverage demonstrate a negative relation with IMR, with coefficients of -0.84 and -0.21, respectively, although the health spending effects vary across regions. Lastly, higher per capita GDP contributes to reducing the IMR. To ensure the validity and reliability of the data results, diagnostic tests, including Pairwise correlation, Multicollinearity, and Heteroskedasticity, were conducted. These tests confirm the model's robustness, allowing for accurate interpretation while also taking into account structural heterogeneity and disparities across countries that shape differential health outcomes. Model's R^2 (0.81), values indicate strong explanatory power, suggesting that selected variables account for a substantial portion of the IMR variations across Asian countries. The findings offer crucial insights suggesting that interventions, including improving water access, enhancing female literacy, and higher public health expenditure, can contribute to reducing the IMR in regions.

Keywords: Female Literacy; Health Expenditure; Infant Mortality Rate; Water Access

INTRODUCTION

Across developing and underdeveloped nations, despite significant progress in reducing the infant and child mortality rates, the issue remains a pressing concern in many Asian countries. The problem is particularly severe in countries including Pakistan, Afghanistan, and Yemen, where the Infant Mortality Rates (IMR) exceed 45 deaths per 1000 births, indicating a critical challenge for public health effects in the regions. IMR is recognised as a sensitive indicator of a nation's overall well-being, and with that, it reflects the combined influence of health, social, and economic determinants (Dutta et al., 2020). Due to an underdeveloped immune system, infants are more vulnerable to diseases and external environmental changes, which increases the risk of mortality among them.

According to the World Health Organisation (WHO) definition, IMR is the probability of a child born in a specific year or period dying before completing one year of age, per 1000 live births (World Health Organization, n.d.). Similarly, the World Bank emphasised that the IMR not only captures health accessibility but also the socio-economic and environmental factors in a broader sense (World Bank, n.d.). The higher IMR in the above-discussed countries illustrates the disparities, including limited access to healthcare, poor maternal nutrition, inadequate sanitation, and insufficient prenatal and postnatal care.

Addressing the issue of high IMR in Asian countries requires an in-depth understanding of the diverse factors that contribute to this problem. Mother's education has been shown to play a major role in this, as an educated mother is more likely to seek timely medical interventions and maintain healthier practices for their children (Uddin & Hossain, 2008). The challenges are compounded by socio-economic factors, including poverty and inequitable access to healthcare services in the countries (Islam & Hyder, 2017). Recent empirical evidence further strengthens this linkage, showing that maternal education significantly reduces child mortality risks and

improves access to maternal care services, even after controlling for socio-economic factors (Madichie et al., 2026). In addition, large-scale evidence from the National Family Health Survey (NFHS-5) highlights the non-linear influence of maternal health, education, and household wealth on under-five mortality (Khan & Das, 2024), while machine learning-based estimates identify antenatal care, birth intervals, and water access as critical determinants (Pandey et al., 2025). The infrastructural issues, such as a lack of clean water and sanitation, exacerbate health risks for infants. Recent systematic evidence also confirms that inadequate water, sanitation, and hygiene (WASH) conditions significantly worsen child health outcomes across developing Asian countries (Rizaldi et al., 2025). There is an essential need to recognise IMR as not just a health issue but also a reflection of the nation's development and policy priorities. Evidence from India further demonstrates that regions with strong public health systems, universal immunisation, and maternal care interventions achieve substantially lower IMR levels (Kapil, 2025). Countries that invest in healthcare infrastructure, female literacy, and a social safety net tend to report lower IMR (Mohsen et al., 2010).

Asian Countries' data for the year 2020 shows significant variations in IMR, from 2 per 1000 live births in countries including Cyprus, Japan, and Singapore, to as high as 54 in Pakistan and 46 in Yemen. These disparities were highlighted in healthcare infrastructure, maternal and infant care, and overall socioeconomic conditions across regions. Among Asian countries, Cyprus, Japan, and Singapore have the lowest IMR at 2, which reflects their advanced healthcare systems and effective maternal and child healthcare programs. Other countries, including Israel, the Republic of Korea, Qatar, Bahrain, and the UAE, also have low IMR (3-6). Countries that come in the middle are Malaysia (7), Turkey (8), Iran (11), and Vietnam (17). Countries like Indonesia (20) and Syria (18) also fall in the middle but face challenges in improving their conditions due to a larger population, conflicts, and economic instability that have impacted healthcare access and quality. Countries like Iraq (21), the Philippines (21), Cambodia (22), and Nepal (24) have high IMR, facing the challenges of limited access to healthcare, mainly in rural areas, and socioeconomic constraints. Pakistan (54), Yemen (46), and Afghanistan (45) have the highest IMR rates in Asia, as they face severe socio-economic challenges, including political instability, poverty, and limited healthcare access.

RESEARCH METHODS

The study objective is to examine the key determinants of infant mortality in Asian countries and assess their impact. Available literature mainly focuses on the SAARC nations, the developed countries, or selected South Asian countries(National Research Council (US) & Institute of Medicine (US), 2013; Saikia et al., 2011). Therefore, understanding the cross-sectional data for Asian countries is important, which this study addresses in two sections. First, a comprehensive view of the factors affecting mortality is presented, followed by the incorporation of key determinants, including access to clean water, female literacy rates, national health expenditure, coverage of child immunisation, and per capita Gross Domestic Product (GDP), to examine their impact. To empirically estimate these relationships, the study adopts a cross-sectional econometric framework using Ordinary Least Squares (OLS) to quantify the marginal effects of socio-economic and infrastructural variables on mortality outcomes. This approach enables the identification of statistically significant determinants while accounting for inter-country heterogeneity in development and health conditions.

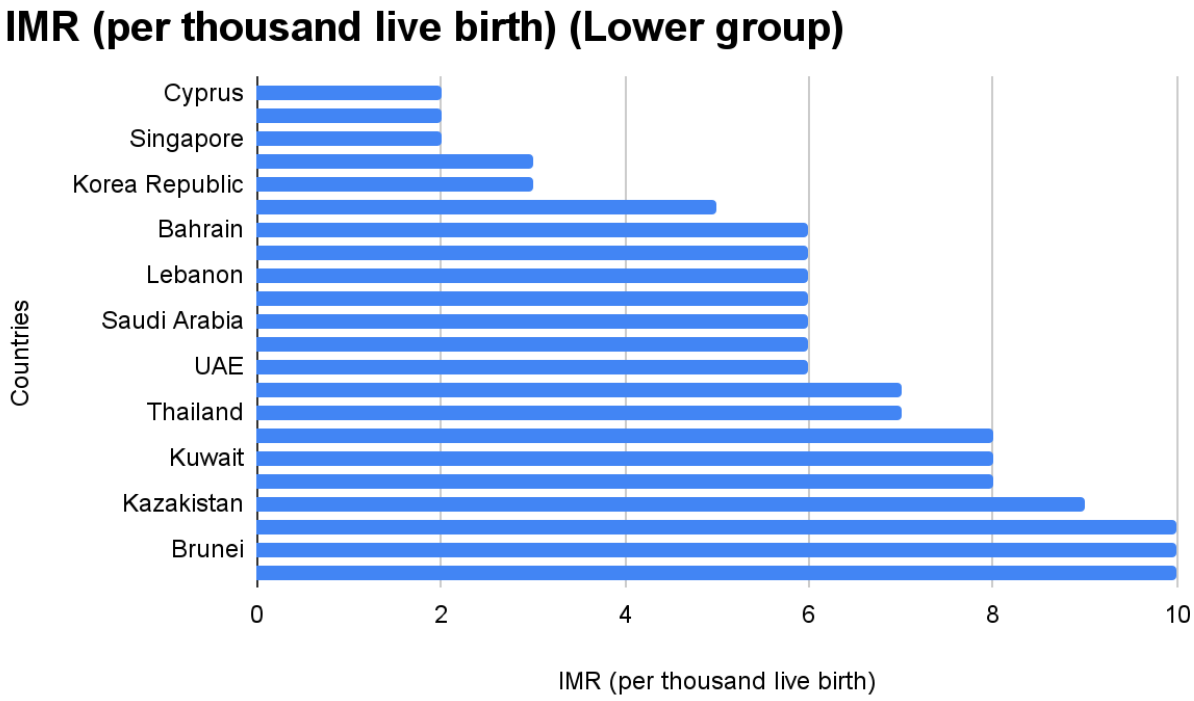


Figure 1: IMR (per thousand live births) in lower group countries

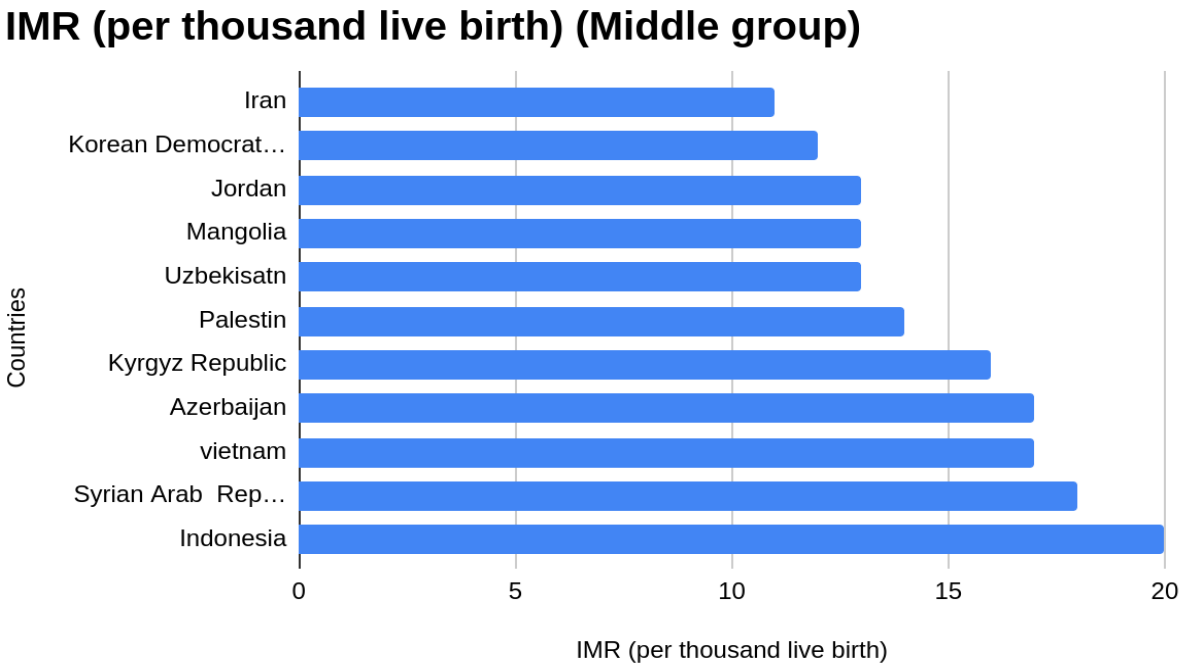


Figure 2: IMR (per thousand live births) in Middle group countries

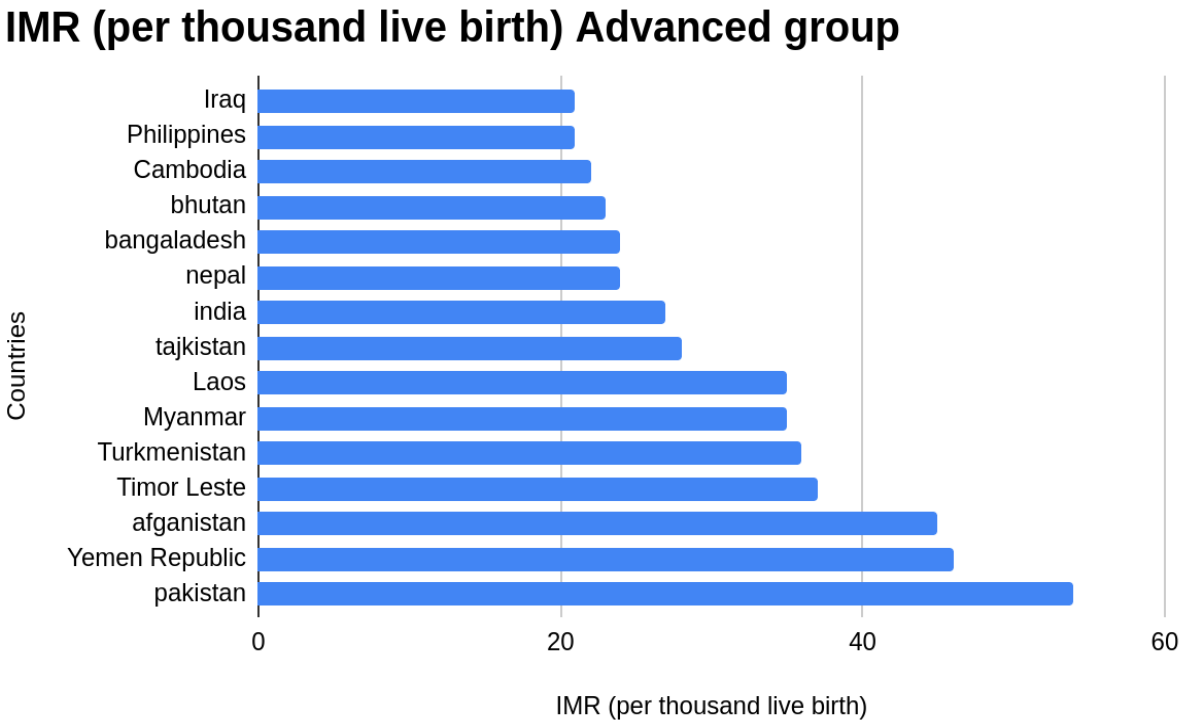


Figure 3: IMR (per thousand live births) in advanced group countries
Source: Author's own calculation using World Bank Data.

Literature Review

The IMR is shaped by various factors, including social, economic, and health care-related factors, and understanding these factors is crucial for effective policy formulation. The key drivers include income, education (particularly female literacy), access to health care facilities, and sanitation. Available literature has consistently highlighted the significant role of stated factors in reducing IMR across different regions. Studies have also emphasised that, in relation to IMR and developmental parameters, there is an intertwined role of economic growth and female literacy, as both serve as robust predictors of lower IMR across regions. Gross National Product (GNP) per capita and female education attainment are influential factors in economic and educational improvement, as they focus on improving access to better healthcare, enhancing nutritional standards, and promoting the overall well-being of children. Studies found that in low-income nations, female literacy rate often outweighs economic factors in its impact on infant survival, which signifies that investments in female education can yield high health benefits even in situations of constrained economic resources (Kateja, 2007; Lu et al., 2010; Mandal et al., 2021; Schell et al., 2007). It signifies the thought that educated mothers are more likely to seek healthcare and maintain better nutritional practices, and also adapt to preventive health measures (Uddin & Hossain, 2008). Studies indicate that while economic development has an important role, enhancing educational opportunities for women can be a more effective measure, mainly in economically vulnerable settings (Schell et al., 2007).

Apart from education and Income, other factors that drive the reduction in infant mortality include access to basic services like sanitation, clean water and healthcare. Available literature shows that improvement in these areas, mainly in developing countries, results in declining IMR. For instance, in SAARC countries, evidence depicted the importance of public health expenditure, women's education and excess to sanitation results in reducing IMR in the long run (Dutta et al., 2020). These findings are in line with broader research, which shows that health

care services and basic sanitation facilities lower the IMR, particularly in low and middle-income countries (Gillani et al., 2021).

Additionally, the mother's age and order of child birth play an important role in determining the IMR, as literature explained that younger maternal age, particularly the teenage pregnancies, are associated with high IMR, the reason being biological immaturity, inadequate parental care and socio-economic disadvantages (Conde-Agudelo et al., 2005). Younger age mothers several times face a greater risk of complications such as preterm birth and low birth weight of the child, which contributes to higher IMR (Fall et al., 2015). In lower-income settings, these risks are compounded, where access to quality maternal healthcare is often limited. Similarly, the higher order of birth has been consistently linked to high mortality, as studies show that with each subsequent birth, the likelihood of mortality increases due to resource constraints, reduced maternal attention and heightened health risk linked with short birth intervals (Rutstein, 2005). High birth order is often observed in families with limited access to family planning services and health care, particularly in impoverished and rural regions (Nove et al., 2014).

Another determinant of infant mortality is health expenditure, especially in the context of underdeveloped public health services. Countries with higher allocation of their GDP to healthcare experience lower IMR, by implementing the immunisation programs and basic healthcare access, which results in improving child health outcomes (Bokhari et al., 2007; Farag et al., 2013; Gillani et al., 2021). Although the relationship between public health care spending and IMR is not universally straightforward, in some regions, it is found that the connection between income and female literacy depicts a more substantial influence on IMR than health care expenditure alone(Anand & Bärnighausen, 2004; Schell et al., 2007), suggesting the need for framing the policies in a direction to address both economic and social determinants. Adding to the literature, the effectiveness of health care expenditure in reducing mortality rates not only depends on the amount that is spent but also on the effectiveness and efficiency of resources that are allocated and managed. In regions where corruption and mismanagement of health care funds are high, the resulting impact of higher spending can be limited (Rajkumar & Swaroop, 2008).

Conditions, including environmental and sanitation, also significantly contribute to mortality outcomes, as literature indicates that inadequate water supply, poor sanitation and degradation of the environment are risk factors that are significant for infant deaths (Sartorius & Sartorius, 2014). Contaminated water source, inadequate disposal of sewage, and pollutant exposure also contribute to waterborne diseases such as diarrhoea and cholera, which disproportionately affect the infants (Fewtrell et al., 2005). In both rural and urban settings, improving water supply and sanitation has resulted in a dramatic reduction in mortality. Studies that are conducted in sub-Saharan Africa and South Asia show that investing in sanitation infrastructure, including providing latrines, safe drinking water and waste management, can reduce the IMR by as much as 20 to 30 per cent. (Esrey et al., 1991). These measures not only reduce the exposure to infant disease but also improve the overall health of the community, resulting in indirect benefits to child survival (Cairncross et al., 2010). In addition to it, environmental degradation, including air pollution and deforestation, has been connected to adverse outcomes for birth and higher mortality. Highly particulate matter (PM 2.5) is linked with higher rates of infant deaths, mainly in regions with rapid industrialisation, caused by industrial pollution (Heft-Neal et al., 2019).

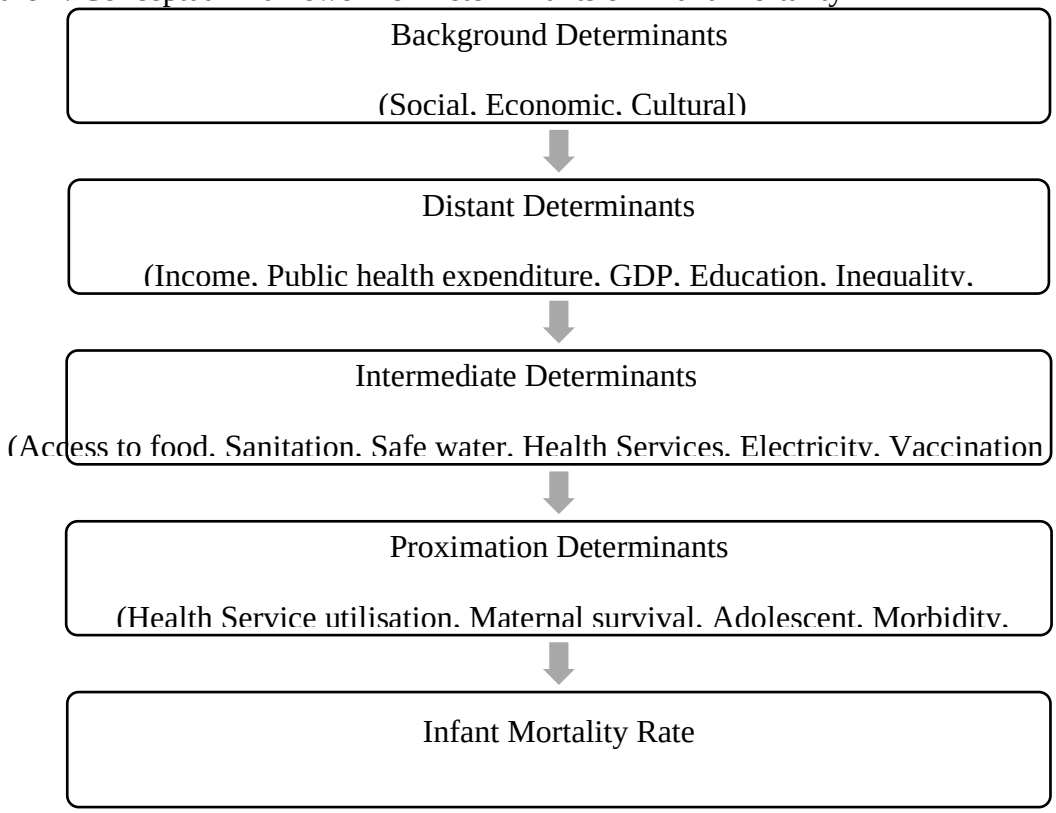
Cultural and social factors, particularly gender inequality, govern maternal healthcare and further complicate efforts to reduce mortality. In traditional settings, where women encounter structural and social barriers in seeking healthcare, the decline in mortality rate is often slower (Ahmed et al., 2010; Jejeebhoy & Sathar, 2001; Sandhya, 1991). Women's autonomy of decision-making is limited by gender discrimination, which restricts their ability to seek timely prenatal and postnatal care (Akinyemi et al., 2019). Norms of society surrounding childbirth often

prioritise men's preferences, particularly in rural settings, leaving women with limited access to health services, especially during conditions of emergencies (Ganle et al., 2014).

The available literature suggests that reducing IMR requires a multifaceted approach that integrates economic growth, improvements in female education, access to basic health services, and public health interventions. These factors work together in synergy to reduce IMR, although their relative importance may differ based on regional and socio-economic contexts.

Infant mortality can be caused by a variety of hierarchical factors, of which some are proximal, such as infections and accidents; then intermediate, including access to electricity and sanitation; and then distal determinants, such as broader societal conditions that are measured by socioeconomic achievements. To assess the individualistic impact of each determinant, multivariate regression models were used to control for confounding variables.

Figure 4: Conceptual Framework of Determinants of Infant Mortality



The given conceptual framework organises the determinants of infant mortality into a structured hierarchy (Dutta et al., 2020; Sartorius & Sartorius, 2014; Schell et al., 2007). To present different levels of hierarchy, five socioeconomic indicators were drawn from an extensive literature review.

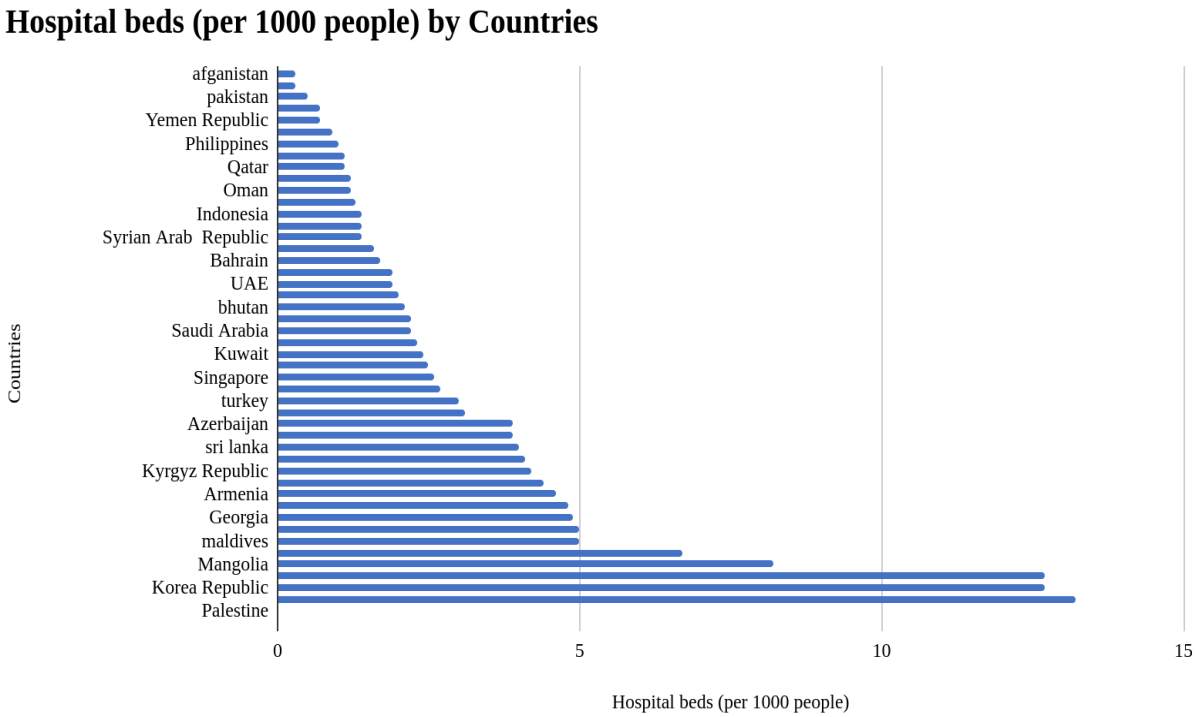


Figure 5: Hospital Beds (per 1000 people) by Asian Countries
Source: Author's own calculation using World Bank Data.

The IMR data of the year 2020 for Asian countries shows vast inequalities in health care access and socioeconomic conditions across the region. While advanced countries like Japan, Singapore, and Israel have reduced their IMR with impressive rates, on the other hand, countries that struggle with high rates of mortality due to conflict, poverty and inadequate healthcare are Pakistan, Afghanistan and Yemen. These disparities show the need for targeted intervention in healthcare and investment in maternal and child health, mainly in poorer and conflict-affected regions. Those countries with a high mortality rate tend to have lower availability of hospital beds per 1000 people. On the other hand, the Asian country Mongolia has an IMR range between 11 and 20, showing a higher availability of hospital beds per 1000 people.

Research Methodology and Data Description

The following variables are used in regression analysis: the dependent variable is IMR, measured as the number of deaths of children under the age of twelve months per 1000 births, which serves as a key indicator of public health. The main data source is the World Development Indicators (WDI) for IMR. The independent variables include, firstly, people using at least basic drinking water services, such as Water, representing the population percentage accessing improved water sources, provided that the time of collection of water is not more than 30 30-minute round-trip. Both basic and safely managed drinking water are included in this parameter, and this data is also sourced from WDI. The second variable is the literacy rate for adult females, written as LR, which measures the percentage of women aged 15 and above who can read and write a simple statement related to daily life. This is an important factor in understanding the role of education among females in reducing infant mortality. The third independent variable is current health expenditure per capita, written as HealthEx, which is included as an independent variable, captures the per capita expenditure on health in US dollars, and it is adjusted for Purchasing Power Parity (PPP). This indicates the investment level in healthcare systems. Fourthly, the independent variable is the immunisation rate for Hepatitis B, written as ImmunizationHepB3, which is measured as the percentage of children aged 12-23 months who received the three doses of the vaccine as per recommendation and serves as a proxy for health

care access and quality. Lastly, the fifth variable is GDP per capita, written as GDPpc, which is calculated as total GDP divided by midyear population and expressed in constant 2015 US dollars. This shows the economic conditions of countries. All the above-listed variables are sourced from WDI to capture the essential aspects of health, education, infrastructure, and economic performance that impact the IMR and provide a comprehensive framework for the multivariate regression analysis.
The regression model is:

$$IMR = \alpha + \beta 1\ water + \beta 2\ LR + \beta 3\ healthex + \beta 4\ immunizationHepB3 + \beta 5 GDPpc$$

Null Hypotheses (H0): $\beta 1 = \beta 2 = \beta 3 = \beta 4 = \beta 5$
Here, a is the intercept, $\beta 1$ is the coefficient for persons using at least water services, $\beta 2$ is the coefficient for the literacy rate of females, $\beta 3$ represents the health expenditure per capita at the current rate, $\beta 4$ represents the coefficient of immunisation rate for hepatitis of health expenditure, and $\beta 5$ is the coefficient of GDP per capita.

RESULTS AND DISCUSSION

OLS, using observations 1-48 (n = 41)
Missing or incomplete observations dropped: 7
Dependent variable: IMR2020

Table 1: Results of the regression model

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	127.198	16.8961	7.528	<0.0001	***
Water	−0.625190	0.194188	−3.220	0.0028	***
LR	−0.315715	0.0567636	−5.562	<0.0001	***
HealthEx	−0.843359	0.435260	−1.938	0.0608	*
immunizationHepB3	−0.213311	0.106499	−2.003	0.0530	*
GDPpc	−0.000199606	7.59728e-05	−2.627	0.0127	**

Mean dependent var	16.04878	S.D. dependent var	12.01447
Sum squared resid	1097.769	S.E. of regression	5.600431
R-squared	0.809874	Adjusted R-squared	0.782713
F(5, 35)	29.81769	P-value(F)	1.10e-11
Log-likelihood	−125.5695	Akaike criterion	263.1389
Schwarz criterion	273.4204	Hannan-Quinn	266.8829

The following are the interpretations of the stated results. The first independent variable, water services, indicated a negative coefficient with a 1% significance level (0.002), which indicates that when water services and availability are improved in the country, it results in decreased IMR. The supporting literature in this relationship shows that the effectiveness of healthcare spending shows that unsafe drinking water has a significant impact on health, life expectancy and infant mortality in Asian economies (Jakovljevic et al., 2020). Adding to that, it is found that greater access to improved water sources and better sanitation facilities is connected with reduced child mortality in Sub-Saharan African countries (Shandra et al., 2011). Other studies observed that child mortality falls by 8% in areas where water services are privatised and has the greatest effect, with a 26 percentage point reduction in the poorest areas (Galiani et al.,

2004). A study was conducted on drinking water salinity and its relation with the mortality rate of infants in coastal Bangladesh using the DHS dataset. This study found that there is a strong link between salinity exposure and IMR after controlling for other determinants (Dasgupta et al., 2016). It is also found that as the proportion of people having access to better water and sanitation facilities increases, it leads to improved health outcomes (Boachie et al., 2020).

The second variable is female literacy rate, which has a negative correlation with IMR at 1% significance level. In relation to other studied variables, this variable best explains the IMR. It is found that as the literacy rate rises, the IMR decreases. Results show that as one standard deviation increases in mothers' education, it increases the probability of both infant and child survival by approximately 13 to 9 per cent, respectively (Islam & Hyder, 2017). A study conducted in Nepal found that when a literate mother gives birth to a child, the child has a 32 per cent lower risk of mortality than one with an illiterate mother. Adding to it, infants whose mothers are involved in decision-making related to health care had a 25 per cent lower chance of dying than those whose mothers are not (Adhikari & Sawangdee, 2011). Education plays an important role in lowering infant and child mortality by raising awareness of healthy living (Rahman et al., 2022). The female's education is a significant predictor of IMR, as educated women are more likely to use healthcare resources effectively, make proper decisions, and take preventive measures for their children.

The health expenditure variable also shows a negative and significant relationship with IMR, indicating that as government health spending increases, the IMR decreases. The literature on this variable is mixed, as some studies support this finding and some have different results. Supporting arguments suggest that IMR falls as it has a positive relationship with per capita health spending (Shetty & Shetty, 2014). Those countries with a lower income category and allocate a regional proportion of state spending to health have a lower IMR. Literature suggests that private health spending does not significantly impact IMR, mainly due to affordability and the issue of accessibility, while state health spending targets the most vulnerable group of society. Although a significant negative relation is found between private health spending and IMR in Sub-Saharan African countries, there is no significant relationship with private health spending (Kiross et al., 2020). A study conducted on OECD countries examined the long-term relationship between Health expenditure and IMR. They found that increasing health expenditure can reduce the IMR, suggesting that health spending should be increased in these countries (Kara & Ersin, 2020). Similarly, a significant negative correlation was found between IMR and health expenditure (Shaahmadi et al., 2015). Some studies argue that government health spending does not necessarily result in better health outcomes; however, it is shown that increasing public health spending can significantly reduce IMR by decreasing out-of-pocket healthcare costs for poor households (Boachie et al., 2020).

The fourth variable is infant immunisation (Hep B3). It has a negative and significant correlation with IMR. Immunisation coverage and IMR in developing countries a major predictors, as it is the most cost-effective preventive health service available, which saves millions of children from vaccine-preventable diseases each year (Shimouchi et al., 1994). Results show that increasing the immunisation coverage reduces IMR by 0.071% (Boachie et al., 2020).

At last, the final variable's result shows that as the GDP per capita of a country increases, the IMR decreases, indicating a significant negative relationship at a 5% level of significance. Available literature on this relationship shows a negative relationship, too (Jakovljevic et al., 2020; Pérez-Moreno et al., 2016; Shaahmadi et al., 2015; Shen & Williamson, 2001). Increasing the strength of the state when controlling for development level has a positive impact on infant survival (Baird et al., 2011). Although the gross national income per capita is associated with IMR, it does not necessarily provide guidelines on how to reduce mortality effectively at any developmental level (Schell et al., 2007).

CONCLUSION

This study contributes to the existing literature on infant mortality by broadening its scope to include Asian countries and integrating key socioeconomic and healthcare determinants. The analysis found that access to clean water, female literacy rates, national health expenditure, immunisation coverage and per capita GDP are the significant factors that determine the IMR. Particularly, access to clean water and female literacy emerge as the most impactful variables, with both showing a strong negative correlation with IMR. This indicates that basic infrastructure and education play a critical role in improving children's health outcomes, particularly in developing countries. The findings show that access to clean water ultimately lowers the IMR, aligning with existing studies and emphasising the role of sanitation and safe water in reducing mortality rates. Additionally, female literacy is found to be a key determinant of IMR, and literate mothers are better equipped to make informed health decisions for their infants this resulting in improved survival rates of infants. Health expenditure also demonstrates a negative relation with IMR, albeit with mixed evidence from the available literature, suggesting that while government spending on the public healthcare system can reduce the IMR, its effectiveness can depend on the structure and reach of the healthcare system. The immunisation rate has a positive influence, particularly the Hepatitis B vaccinations, on reducing IMR, highlighting the importance of sustained public health initiatives. Finally, the study found an inverse relationship between GDP and IMR, illustrating that economic development plays a crucial role in improving health outcomes. The regression model's robustness was evidenced by a high R-squared value, which reinforces the significance of these socioeconomic and healthcare variables in explaining variations in infant mortality across countries.

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