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The Impact of Human Capital Development on the Under-5 Mortality Rate in South Africa

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Abstract

While many scholars argue that education plays a significant role in promoting human capital development evidence suggest that South Africa's human capital index is relatively lower than other countries (0.4 in 2020) as the nation is still making strides in boosting its childhood environment and this is seen in its under-5 mortality rate (U5MR) which has increased enormously between 2020 and 2022 from 29 to 40 deaths per 1000 live births. The study examined the impact of human capital development on U5MR in South Africa using time series data spanning from 1994 to 2023. The Ordinary Least Squares (OLS) method was utilized to investigate the long run correlation between U5MR and explanatory variables, namely female literacy (FL), health access and quality (HAQ), child immunization rate (CIR), access to improved sanitation and clean water (ISW) and prevalence of HIV/AIDS (POH) in South Africa. The analysis reveals that FL, HAQ and CIR have an insignificant correlation with U5MR. Furthermore, the analysis shows that there exists a positive correlation between ISW and U5MR and a negative correlation between POH and U5MR in the nation. This study, therefore, recommends the "start before conception and continue through the postpartum period" strategies by the health facilities to reduce under-5 mortality in local and international contexts.

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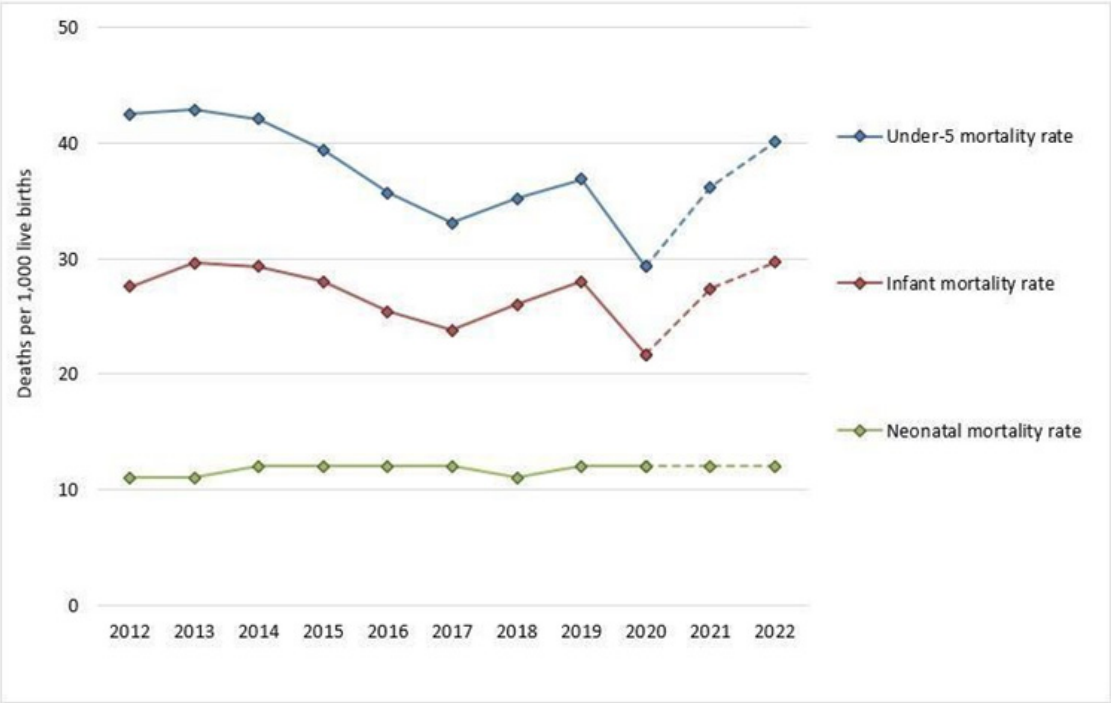
Introduction

Human capital refers to people's efficiency and ability to transform raw materials into goods and services, with the consensus being that skills can be acquired or learnt through the educational systems (Son, 2010). Nations with a high level of human capital development index (HDI), mainly through education, also have a high level of economic development measured in their per capita income (PPI). Within the sphere of economics, the focus on this area has often been on how the accumulation of human capital responds to the early childhood environment (Janet & Douglas, 2011).

While many scholars argue that education plays a significant role in promoting human capital development evidence suggest that South Africa's human capital index is relatively lower than other countries (0.4 in 2020) as the nation is still making strides in boosting its childhood environment and this is seen in its under-5 mortality rate (U5MR) (Gamede, 2017) – which has increased enormously between 2020 and 2022 from 29 to 40 deaths per 1000 live births (Nannan & Hall 2024). The table below shows how the mortality rate of under-5 (per 1,000 live births) in comparison with infant mortality and neonatal mortality rates has dramatically increased in the years mentioned above.



Source: Nannan and Hall (2024)

While South African reports and studies locally and internationally attribute the leading causes of under-5 5-mortality to diarrhoeal diseases, lower respiratory infections, ill-defined natural causes, HIV/AIDS and low female literacy rates (Nannan, Dorrington, Laubscher, Zinyakatira, Prinsloo, Darikwa, Matzopoulos & Bradshaw, 2012; karyani, Kazemi, Shaahmadi, Arefi & Meshkani 2015 and Batool, Shah, Dar, Skinder & Jeelani,2020) – the leading cause of the under-5 mortality between 2020 and 2022depicted on the table above is generally diarrhoea, pneumonia and other respiratory infections. Notwithstanding the COVID-19 shock, which devastated the economy, society and people's livelihoods, the implemented lockdown measures played a crucial role in reducing child mortality (Nannan & Hall 2024).

Moreover, to improve human capital development and reduce the under-5 mortality rates, South Africa has implemented various policies and strategies. Regarding human capital development, the nation has increased its spending towards education, as it is the core of human capital development, even though it yields low outcomes (PwC,2024), and put in place early childhood development (ECD) initiatives towards the reduction of

child mortality, although they have been historically underfunded by the government (Dulvy, Gebre, Kika-Mistry, Franz, Lee, Kabubei, Matsebula, Monchuk & Cunningham, 2025).

While studies prove a positive correlation between under-5 mortality and per capita income, no significant correlation between U5MR and government health expenditure and education, a significant correlation between government health expenditure and U5MR, while immunisation and health workers have a positive insignificant link (Kalu, Ihezukwu & Nga,2023; Adibe, Mgbemena & Kalu, 2021; Igwe & Uhrie, 2022 and Agbatogun & Opeloyeru, 2020) – there is relatively a lack of empirical studies that quantitatively focus mainly on how human capital development influences U5MR using time-series models in the recent literature in both local and international contexts. Therefore, this study will utilise time series data to quantitatively examine the impact of human capital development on U5MR in South Africa, including variables such as education, healthcare access and quality, child immunisation rate, access to improved sanitation and clean water and prevalence of HIV/AIDS as explanatory variables in the study's analysis.

Literature Review

Theoretical Literature

This part of the study pertains to presenting the theoretical framework applied in this study, with the main subject on the topic being the human capital theory, developed by Gary Becker and Theodore Schultz in the 1950s and the early 1960s. the theory emphasises that investments in education and training yield a more productive and efficient workforce that contributes significantly to the growth of the economy and the society, with the more educated individuals being likely to earn high and spend significantly towards their health. Other theories, such as the classical theory of growth (18th and 19th centuries) and the modernisation theory (1950s and 1960s) and their relevance to the study are examined.

The Human Capital Theory

Developed in the 1950s and the early 1960s by Gary Becker and Theodore Schultz, the human capital theory posits that an economy with high investments in education and training is more likely to have a more efficient and productive workforce. The theory emphasises that a well-educated population is more likely to earn more, with the educated individuals spending more towards their health among their spending (Watts & Samoszuk, 2023). Within the context of this study, the theory suggests that increased investments in education yield not just efficient and productive workers, but individuals who take good care of their health. In simple terms, high literacy rates might contribute to a reduced number of under-5 mortality rates as the educated individuals would spend significantly towards their health, provided that education increases their earnings.

The Classical Theory of Growth

This theory was developed by Adam Smith and David Ricardo in roughly the 18th and 19th centuries and posits that an increasing population growth might reach a point where the economy starts decreasing in terms of wealth due to overpopulation. The core assumption of this theory is that unlimited needs and wants cannot be satisfied with limited resources. This assumption is also supported by economists, as they affirm that a growing population has no benefit in society (Ackerman & Wells, 2023). Within the context of this study, the theory implies that if an economy grows at a rate which is faster than economic growth, eventually the resources will not be sufficient enough to meet all of the population's needs and wants as they are limited. In simple terms, if an economy grows at a rate relatively lower than the economic growth, the government might not be able to provide basic services such as education and healthcare services to all individuals in the society, which in turn would result in poor healthcare services, which increase the infant and under-5 mortality rate.

The Modernisation Theory

The modernisation theory was developed by Walt Whitman Rostow, Bert Hoselitz, Daniel Lerner, Seymour Martin Lipset, Neil Smelser, David McCleeland, and others between the mid- 1950s and mid-1960s in the United States of America (Da Silva, 2021). This theory describes development as an evolutionary, uniform route that all societies follow from agricultural, rural, and traditional societies to urban, postindustrial and modern forms (Ynalvez & Shrum,2015). Within the context of this study, this theory emphasises the

role of economic development in transitioning societies from rural and traditional to urban and modern forms. This theory suggests that as societies become more advanced, it enables better access to healthcare. In simple terms, economic development promotes rural-urban migration, improved infrastructure (both rural and urban) and better access to healthcare services (increased healthcare technologies) that reduce infant and under-5 mortality rates.

Empirical literature

This section presents an overview of studies that have been conducted in this area and are relevant. This includes studies such as those of Kalu, Ihezukwu & Nga (2023) who investigated the relationship between under-5 mortality rate and health human capital in Sub-Saharan African (SSA) nations between 1995 and 2022. Their study utilized the dynamic panel vector autoregressive (PVAR) technique, anchored on the theoretical framework of Grossman's health production function. Their study found that a positive correlation between per capita income and under-5 mortality rate, with an adverse correlation between under-5 mortality rate and electricity consumption.

Similarly, another study by Chukwuemeka, Onyinye and Kalu (2021) analysed the drivers of under-5 mortality rate and health human capital in sub-Saharan African (SSA) nations between 1995 and 2020. Using the dynamic panel vector autoregressive (PVAR) technique, anchored on the theoretical framework of Grossman's health production function, the study revealed that per capita income positively influences the under-5 mortality rate, and electricity consumption positively influences the under-5 mortality rate.

Igwe & Uhrie (2022) explored government health expenditure, education and ubnder5 mortality rate in Nigeria using time-series data between 1982 and 2019. Their study found that both government spending and education are sufficient to decrease the under-5 mortality rate in short-term within the nation.

A study by Ayipe and Tanko (2023) examines the correlation between public healthcare spending and the under-5 mortality rate in low-income nations of SubSaharan Africa using data sourced from the World Development Indicators between 2000 and 2019. The study found that there exists a significant negative correlation between domestic health spending and under-five mortality rate in low-income nations of Sub-Saharan Africa.

Oshinfowokan (2024) investigated Human Capital Development and Governance Strategy in Nigeria-from the Perspective of Sustainable Development Goals. Their study utilised secondary methods of collecting data. The study found that Nigerians (about 133 million) have become more poorer in last 8 years with another 1.7m set to join them by the end of 2023. failed governance resulting in Goal 2: Zero Hunger, Goal 3: Good health and Wellbeing and Goal 4 Quality Education not being fully effective within the nation.

Gao, Aderemi, Zhou, Olanipekun and Bassey (2023) explored the impact of household socio- economic factors on maternal mortality and under-five survival in Nigeria between 2005 and 2021 using data collected from the World Development Indicators and fully modified least squares and canonical cointegrating regression. Their study found that per capita GDP has a positive insignificant, correlation with the under-5 mortality rate, while national income was significantly correlated with maternal mortality.

Olawade, Wada, Aderinto, Odetayo, Adebisi, Esan and Ling (2025). Investigated the Factors contributing to under-5 child mortality in Nigeria. The study utilised peerreviewed articles and reports published in English to identify and synthesise data about factors that contribute to under-5 mortality. Their study found that among the factors revealed by the study, a high burden of preventable and communicable diseases plays a pivotal role in under-5 mortality.

Murthi and Shekar (2021) investigated the correlation between breastfeeding and economic growth in South Africa in 2019. Their study found that breastfeeding has a significant impact on productivity and economic growth, as it is a child's first immunisation and is the most significant life-saving intervention for young children.

Ekwoaba and ekwoaba (2023). Explored how women's education could be positioned to decrease inequalities and enhance the well-being of society. Their

study utilised secondary data from the 2018 Nigerian Demographic and Health Survey (NDHS). Their study found that there exists a high negative relationship between women's education and under-5 mortality.

Nyaramba (2017). Investigated the determinants of socioeconomic inequality in under5 mortality in Kenya. Their study used the 2003, 2008/09 and 2014 KDHS datasets. Their study found that under-five mortality was mostly in poor households. Furthermore, birth order and the size of the child at birth, birth interval, age of the mother and Sanitation facilities are the main contributors of under-five child mortality in the Nation.

Isola and Alani (2012) examined the various measures of human capital development in Nigeria. The study utilised data from Nigeria and adopted the growth account model, which specifies the growth of GDP as a function of labour and capital. Their investigation found that education and health are significant contributors to economic growth in Nigeria

Adeley, Olohunlana. Ibukun, Soremi and Suleiman (2022) examined the Mortality rate, carbon emissions, renewable energy and per capita income nexus in Sub-Saharan Africa between 2005 and 2019. Their study utilised an unbalanced sample of 47 SubSaharan African countries. Their investigation reveals that CO2 emissions have a positive link with mortality rates, and real per capita income is correlated with decreased mortality rates.

A study by Muthaka (2013) explored Health Expenditures and Child Mortality in Kenya. Their study utilised the structural linear probability models of neonatal, infant, and under-five mortality. Their study found that the under-five mortality impacts the correlation between private and public health expenditures was statistically significant.

Bognet (2023) examined the correlation between government expenditure in education and human capital development on control of corruption in Nigeria between 1996 and 2019 using the Fully Modified Least Squares (FMOLS) estimation technique for the analysis. Their study found that as the control of corruption rises, the government shows significant improvement in human capital development.

In a study by Madueme, Orji, Johnson and Anthony-Orji (2021), the socio-economic spending and human capital development nexus between 1981 and 2018 in Nigeria is examined. The study uses the Autoregressive Distributed Lag Model (ARDL) in the analysis. Their analysis reveals that per capita income significantly influences human capital development.

Methodology

Model specification

To examine the influence of human capital development on U5MR, the following mathematical model is described:

$$Y = f(F, H, C, I, H) \quad (1)$$

Where Y is the aggregate real output F = female literacy, H =health access and quality, C = child immunisation rate, I =access to improved sanitation and clean water and H = HIV/AIDS prevalence. However, the main focus of the study is on the influence of human capital development on U5MR, not economic growth; therefore, building on the work of Kalu, Hezukwu and Nga (2023), the following model is specified:

$$U5MRt = \beta 0 + \beta 1Ft + \beta 2Ht + \beta 3Ct + \beta 4It + \beta 5Ht + \varepsilon t$$

(2) Where: U5MR is the five-mortality rate at time t and $\beta 0$ is the intercept, $\beta 1$ *to* $\beta 5$ are coefficients of the parameters. F is female literacy at time t, H is health access and clean water at time t, C is child immunisation at time t, I is improved access to sanitation and clean water, and H is HIV/AIDS prevalence at time t, and ε is the error term at time t. It is expected that $\beta 1$ *to* $\beta 5 < 0$. Thus, a negative correlation between all the explanatory variables and U5MR is expected. Mortality rate, under-5 (per 1,000 live births) is used as a proxy for U5MR, Literacy rate, adult female (% of females ages 15 and above) is a proxy for female literacy rate, Current health expenditure per capita (current US$) is a proxy for health access and quality, Prevalence of overweight, weight for height (modeled estimate, % of children under 5) is a proxy for immunization, Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (per 100,000 population) is a proxy for access to improved sanitation

and clean water and Prevalence of HIV, total (% of population ages 15-49) is a proxy for HIV/AIDS. All the data collected from the World Bank World Development Indicators https://databank.worldbank.org/source/world-development-indicators.

Data sources

The study used time-series data covering the period from 1994 to 2023 from The World Bank World Development Indicators. The data utilised by the study is on an annual basis. The period chosen for the study is significant as it is attributed to economic and political changes. Since the World Bank is an accredited secondary data source, it is good for this study. 3.3 Estimation techniques

The study employed the ordinary least squares method to examine the long-run correlation between human capital development and under five mortality rates in South Africa. The Ordinary Least Squares (OLS) is a commonly used method that is utilised to examine the relationship between one or more variables (Zdaniuk, 2024). Several diagnostic tests were performed in the study, including the Jarque-Bera test, Serial correlation was utilised using the Breusch-Godfrey test, and heteroscedasticity was tested with the ARCH tests. The stability of parameters was also assessed using the CUSUM and CUSUMQ tests. Overall, these tests will help determine the validity and reliability of the model's results.

Empirical results

Descriptive Statistics

The aim of Table 1 is to provide a summary of the statistical data that presents the variables examined in this study. The investigation found that all variables in the study have positive mean coefficients, indicating an upward trend over the series. The data has low deviation, suggesting it is centred closely on the average. Skewness values are mostly negative, with only health access and quality (LHAQ) being positive. Under5 mortality rate (U5MR) is mesokurtic, while all the other variables are platykurtic, except for child immunisation, which is leptokurtic.

Table

	LU5MR	LFL	LHAQ	LCIR	LSIW	LPOH
Mean	3.760171	4.513366	6.300020	4.383689	2.567463	2.894084
Median	3.678829	4.521789	6.289352	4.430817	2.572612	2.901422
Maximum	4.275276	4.553877	6.532149	4.454347	2.587764	2.933857
Minimum	3.529297	4.454347	6.120682	4.248495	2.509599	2.803360
Std. Dev.	0.234427	0.030611	0.139594	0.080262	0.024924	0.042808
Skewness	1.043398	-0.868438	0.261245	-0.725274	-1.226640	-0.894185
Kurtosis	3.074027	2.593482	1.848407	1.792565	3.554588	2.725582
Jarque-Bera	1.998426	1.458413	0.732949	1.632577	2.899485	1.500386
Probability	0.368169	0.482291	0.693174	0.442069	0.234631	0.472275
Sum	41.36188	49.64703	69.30022	48.22058	28.24209	31.83493
Sum Sq. Dev	0.549559	0.009371	0.194866	0.064420	0.006212	0.018326
Observations	11	11	11	11	11	11

Notes: **5% significance level. Source: Author's own drawing. Results obtained from Eviews 10.

Correlation Test

Table 2 presents the results obtained from this analysis.

Table 2 indicates that there exists a weak negative correlation, with a magnitude of 0.251271, between the under-five mortality rate (U5MR) and female literacy (FL). Conversely, there is a weak negative correlation, with a magnitude of -0.201599, between the under-five mortality rate (U5MR) and health access and quality (HAQ). Another weak negative correlation is observed between the under-five mortality rate (U5MR) and child immunization (CIR), with a magnitude of -0.438323. Furthermore, there is a strong negative correlation, with a magnitude of -0.957180, between the under-five mortality rate (U5MR) and access to improved sanitation and clean water (SIW). Additionally, there exists a strong negative correlation, with a magnitude of 0.949086, between the under-five mortality rate (U5MR) and the prevalence of HIV/AIDS. The variables exceeding a correlation of 0.7 suggest a high correlation, while those below indicates a weak correlation.

Table 2

	LU5MR	LFL	LHAQ	LCIR	LSIW	LPOH
LU5MR	1.000000	-0.251271	-0.201599	-0.438323	-0.957180	-0.949086
LFL	-0.251271	1.000000	0.229333	-0.236902	0.359655	0.299763
LHAQ	-0.201599	0.229333	1.000000	-0.554235	0.142542	0.042513
LCIR	-0.438323	-0.236902	-0.554235	1.000000	0.365213	0.455176
LSIW	-0.957180	0.359655	0.142542	0.365213	1.000000	0.990134
LPOH	-0.949086	0.299763	0.042513	0.455176	0.990134	1.000000

Source: Author's drawing. Results obtained from EViews 10

Ordinary Least Squares (OLS) Results

Table 3: Shows the Findings OLS Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFL	0.723678	1.457797	0.496419	0.6373
LHAQ	-0.571716	0.384623	-1.486430	0.1877
LCIR	0.135227	0.617796	0.218886	0.8340
LISW	20.32737	8.474685	2.398599	0.0534**
LPOH	-16.82293	4.699876	-3.579441	0.0117**
R-squared 0.859233 Mean dependent va 3.760171 Adjusted R-squared 0.765388 S.D. dependent var 0.234427 S.E. of regression 0.113549 Akaike info criterion -1.210215 Sum squared resid 0.077360 Schwarz criterion -1.029354 Log likelihood 11.65618 Hannan-Quinn criter -1.324223 Durbin-Watson stat 1.303160				

Notes: ***1%, **5% significance level. Source: Author's own drawing. Results obtained from Eviews

A positive correlation exists between the female literacy rate and the under-five mortality rate, where a unit increase in female literacy rate will lead to an increase in the under-five mortality rate by 0.723 units. The t-statistic of 0.496419 is less than the critical value of 2, and the probability of 0.6373 is above the 5% significance level, indicating that the results are insignificant.

A negative correlation exists between health access and quality and the under-five mortality, where a unit increase in health access and quality leads to a decrease in under-five mortality by -0.571 units. The t-statistic of -1.486430 is less than the critical value of 2, and the probability of 0.1877 is greater than 5%, indicating

that the results are statistically insignificant at a 5% level.

A positive correlation exists between the child immunization rate and the under-five mortality rate, where a unit increase in child immunization will lead to an increase in the under-five mortality rate by 0.135 units. The t-statistic of 0.218886 is less than the critical value of 2, and the probability of 0.8340 is above the 5% significance level, indicating that the results are insignificant.

Another positive relationship exists between access to improved sanitation and clean water and the under-five mortality rate, where a unit increase in access to improved sanitation and clean water will lead to an increase in the under-five mortality rate by 20.327 units. The t- statistic of 2.398599 is above the critical value of 2, and the probability of 0.053 is less than the 5% significance level, indicating that the results are statistically significant.

Lastly, A negative correlation exists between the prevalence of HIV/AIDS and the under-five mortality, where a unit increase in prevalence of HIV/AIDS leads to a decrease in under-five mortality by -16.822 units. The t-statistic of -3.579441 is greater than the critical value of 2, and the probability of 0.011 is less than 5%, indicating that the results are statistically significant at a 5% level.

Diagnostic Tests

Normality Test

The Jarque-Bera test was conducted, and its results are represented in figure 1 below.

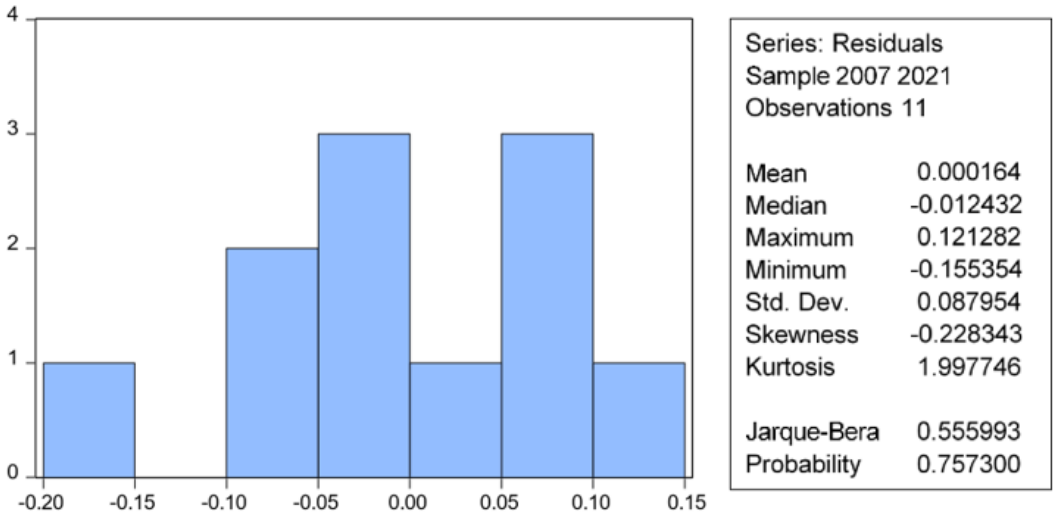


Figure 1: Jarque-Bera

The outcomes indicate that the probability of the results is above the five per cent significance level, suggesting that they are statistically insignificant. Consequently, we fail to reject the null hypothesis that the residuals are in compliance with the normal distribution. 4.6 Serial correlation

Table 4 displays the outcomes of the Breusch-Godfrey test

F Statistic	0.266700	Prob. F	0.7785
Obs*R Squared	1.294262	Prob.Chi-	0.5235

Source: Author's own drawing. Results obtained from Eviews

The results conclude that the probability of 0.77, which is above the 5% significance level, is statistically insignificant. Consequently, the null hypothesis that presumes an absence of serial correlation within residuals is not rejected.

Table 5: ARCH Test for Heteroscedasticity

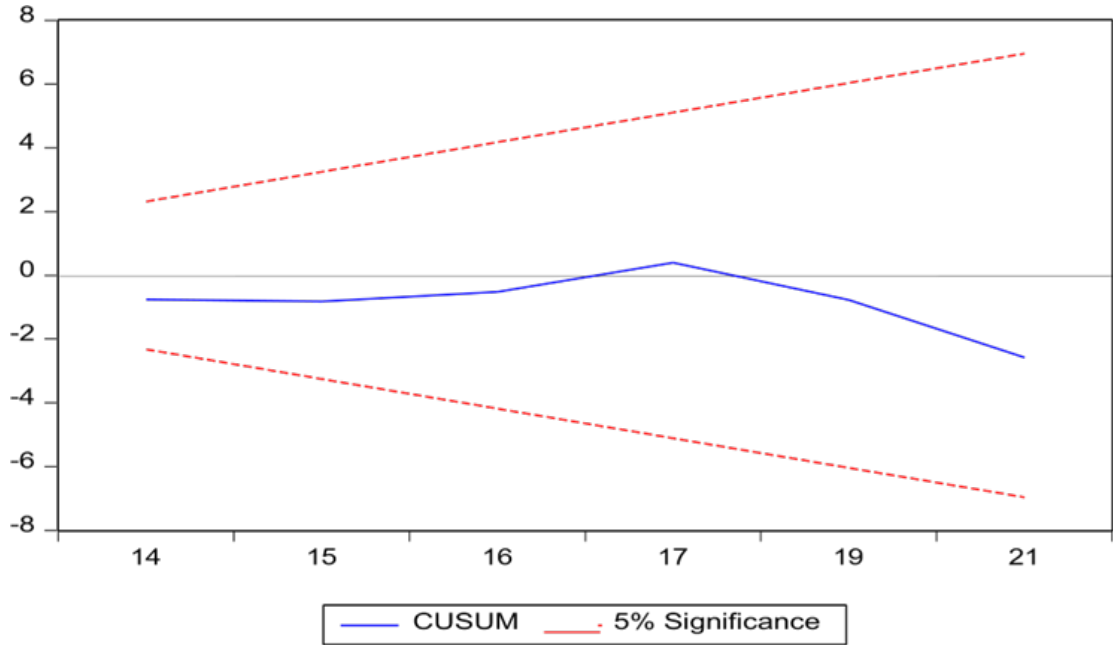
F-statistic	0.229635	Prob. F	0.6568
Obs*R-squared	0.325751	Prob.Chi-Square	0.5682

Source: Author's own drawing. Results obtained from Eviews

The outcomes are statistically insignificant because the probability chi-squared is more than the 5% significance level. We accept the null hypothesis of no heteroscedasticity in residuals.

4.7 Parameter stability tests

Cusum Test

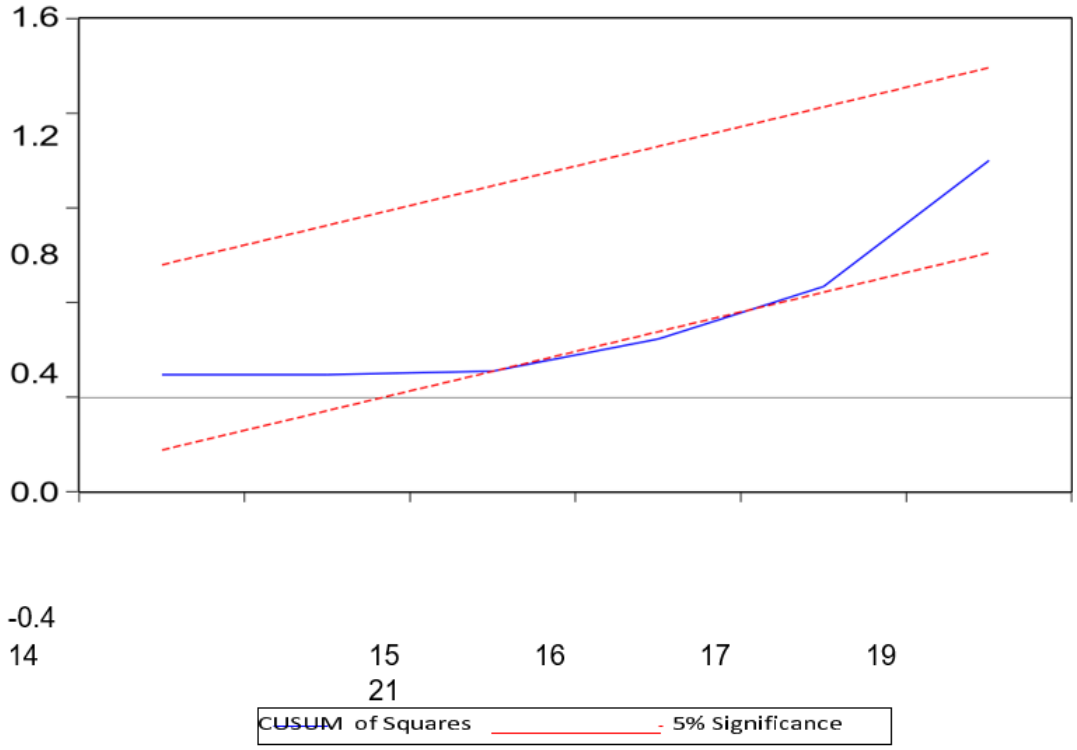


Source: Author's own drawing. R results obtained from Eviews

Figure 2

The blue line in the graph denotes the value of CUSUM, which is set against the 5% level of significance shown by the red lines. This indicates that there are no anomalies or inconsistencies in the coefficients, ultimately suggesting that the series or model examined is stable and consistent.

Cusum of Squares Test



Source: Author's own drawing. Results obtained from Eviews

Figure 3

The CUSUMQ, indicated by the blue line in the graph, has values that fall within the red lines representing the 5% significance level, however, along the way they slighly overlap the lines. This shows that there is an error in the model that leads a slight instability, however overall, the coefficients have no instability or irregularity. In conclusion, the model being assessed is deemed stable based on this test.

Conclusion of the Empirical Findings

The main purpose of the empirical results was to present an interpretation and evaluation of the results obtained from the analysis. According to the findings, the main explanatory variable, female literacy, along with health access and quality and child immunization, was identified to have no impact on the under-five mortality as it was proven to be insignificant. Control variables, namely access to improved sanitation and clean water and prevalence of HIV/AIDS, were identified to have a significant impact on the under-five mortality rate in South Africa.

Policy Implications and Recommendations

The study therefore underscores the importance of child immunization and HIV/AIDS prevalence in reducing the under-five mortality rates in the nation. Therefore, drawing from the findings, there is a need for transformative and comprehensive policies to address the high number of deaths among children under the age of five. Therefore, the study proposes increased investments and awareness in the SBCATP (start before conception and continue through the postpartum period) strategy. Before conception, women must be screened for health risks and pre-existing chronic conditions such as sexually transmitted diseases, diabetes and hypertension, counselled about the possibility of using contraceptives to prevent unintended pregnancies and unnecessary abortions, be encouraged about good nutrition and the value of regular physical exercise. During pregnancy, women must be provided early access to increased quality care through pregnancy, labour and delivery, and monitored to treat preexisting chronic diseases, be vaccinated against influenza and educated about initial signs

of pregnancy-related problems. During the postpartum period, newborn babies must always be vaccinated at appropriate times, provided with all the necessary information abo well-baby care and breastfeeding benefits, and lastly educate the parents on how to protect the children from exposure to infectious diseases and harmful substances.

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