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WOMEN'S HIGHER EDUCATION AND INFANT SURVIVAL RATES: TRENDS AND CORRELATIONS IN INDIA

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ABSTRACT
This study examines the association between women's enrolment in higher education and the Infant Mortality Rate (IMR) in India from 2011 to 2022, utilizing IMR data from the Sample Registration System (SRS) and enrolment data from the All-India Survey on Higher Education f(AISHE). Employing the Phillips-Perron test to assess stationarity, Johansen's cointegration test for long-term relationships, and a Vector Autoregressive (VAR) model to analyse short-term dynamics, the study finds that IMR exhibits strong persistence, with its first lag significantly influencing its current value. However, no immediate short-term causal link is detected between higher education enrolment and IMR, indicating that the effects of increased female education on child mortality are mediated through indirect socioeconomic channels rather than manifesting instantaneously. Education plays a crucial role in improving maternal awareness, healthcare utilization, and family planning, but its direct impact on reducing IMR depends on complementary factors such as healthcare access, economic stability, and social support systems. While higher education empowers women and contributes to long-term social development, its influence on IMR reduction requires an integrated policy approach that enhances healthcare infrastructure, expands economic opportunities, and strengthens social welfare measures. The study underscores the need for holistic interventions that bridge the gap between educational attainment and health improvements, ensuring that gains in women's education translate into tangible reductions in infant mortality. Future research could explore regional disparities, maternal employment, and healthcare accessibility to better understand the mechanisms linking education to child survival outcomes, helping policymakers design more effective strategies for improving maternal and child health in India.
KEY WORDS: *Women's Higher Education, Education and Health Outcomes, Infant Mortality Rate (IMR), Public Health, Women's Participation in Education.*

INTRODUCTION
Education is widely regarded as one of the most powerful tools for societal development, particularly when it comes to improving health outcomes. A growing body of research emphasizes the positive impact of women's education on maternal and child health (Caldwell, 1979; Desai & Alva, 1998). In particular, higher education for women has been associated with improved health literacy, increased independence in decision-making and improved access to healthcare services. (Basu, 1999). These factors are essential in mitigating adverse outcomes, including the Infant Mortality Rate (IMR), a vital indicator of public health. The IMR, defined as the number of deaths of infants under one year of age per 1,000 live births (World Health Organization, 2024), remains a critical measure of the health and well-being of populations, especially in developing countries (UNICEF, 2022). Despite substantial global improvements, IMR remains a pressing issue in many regions. Socioeconomic factors such as poverty, healthcare infrastructure, and maternal education have long been identified as key determinants of IMR (Victora et al., 2003). Among these, maternal education, particularly at the tertiary level, is increasingly recognized as a transformative factor that enhances maternal health behaviors and practices, leading to better outcomes for infants (Cochrane, 1979).

This paper aims to explore the interdependency between women's enrolement in higher education and IMR from 2011 to 2022. While previous studies have established a link between basic education and health outcomes (Cutler & Lleras-Muney, 2010), the role of higher education remains underexplored, especially over the past decade, which has witnessed significant advancements in women's education. By analyzing the trends and correlations between tertiary education and IMR, this study seeks to provide insights into how further investment in women's education can contribute to public health improvements.

REVIEW OF LITERATURE
A growing body of literature underscores the significant influence of women's education, particularly higher education, on improving child health outcomes, especially in reducing the Infant Mortality Rate (IMR). Early studies by Caldwell (1979) and Cochrane (1979) Research indicates that women with higher education levels are more likely to engage in health-promoting behaviours, such as seeking antenatal and postnatal care, ensuring proper nutrition, and utilizing family planning services. These

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behaviours directly influence maternal and infant health, contributing to lower IMR. Desai and Alva (1998) and Gakidou et al. (2010) further highlight that higher education, particularly at the tertiary level, equips women with better health knowledge, allowing them to make well-informed choices regarding healthcare and child-rearing. Women with higher education are also more likely to delay marriage and childbearing, reduce high-risk pregnancies, and ensure proper spacing between births, which are critical factors in lowering IMR (Jejeebhoy, 1995; Bongaarts, 2003). Additionally, Bhalotra and Rawlings (2011) highlight that women with tertiary education often secure better economic opportunities, which lead to improved access to healthcare for themselves and their children, further reducing the likelihood of infant deaths.

Higher education also increases women's ability to navigate healthcare systems, ensuring timely access to medical services and preventive care for both themselves and their infants. Although the impact of basic education on health outcomes is well-documented, the extent to which higher education contributes to reducing IMR remains less explored. Some studies, such as those by Filmer and Pritchett (1999) and Victora et al. (2003), suggest that the impact of higher education on IMR may be mediated by other factors, including the availability and quality of healthcare services, economic conditions, and broader social infrastructure. Despite these complexities, recent trends from 2011 to 2022 show that regions with increased women's enrolment in higher education have generally experienced declines in IMR. However, the full potential of higher education to reduce IMR is realized only when healthcare systems and social services are adequately developed to support the translation of educational gains into better health outcomes (UNICEF, 2022). While many studies have established this connection, the specific role of higher education, as opposed to primary or secondary education, is still an emerging field of study. Research indicates that higher education enhances health literacy, decision-making autonomy, and access to healthcare services, all of which play a vital role in lowering infant mortality. However, further research is needed to explore the interrelation between higher education, healthcare infrastructure, and other socio-economic factors, particularly in the context of recent trends from 2011 to 2022.

DATABASE AND METHODOLOGY

This study seeks to examine the relationship between women's enrolement in higher education and the Infant Mortality Rate (IMR), using data from 2010-11 to 2021-22. The enrolment data for women in higher education is sourced from the All India Survey on Higher Education (AISHE), while the IMR data is obtained from the Sample Registration System (SRS).

The Phillips-Perron Unit Root test was conducted to assess stationarity, revealing that both variables are non-stationary in levels but stationary in first differences. Subsequently, the Johansen cointegration test examined the existence of a long-term equilibrium relationship, while the Akaike Information Criterion (AIC) determined the optimal lag length (Akaike, H. 1974) of 2 for the Vector Autoregression (VAR) model. The VAR model was then estimated using the first differences of the variables, and Granger causality tests were performed to evaluate the predictive relationships. Impulse response functions and variance decomposition analyses were carried out to investigate short-term dynamics and evaluate the extent to which each variable contributes to the forecast error variance. The statistical analyses were carried out using E-views, providing a robust framework for understanding the dynamics between women's higher education and infant mortality rates in India.

HYPOTHESIS

- There is No significant relationship between the enrolment of women in higher education and Infant Mortality Rate.

DATA ANALYSIS AND INTERPRETATION

For time series analysis, it is essential that the variables are stationary (Gujarati, 2007). The Phillips-Perron Unit Root test is utilized to check if the data has a unit root (Phillips, P. C. B., & Perron, P., 1988).

Table 1: Philips-Perron Unit Root test Statistics

Variable	Level (P Value)		Fisrt Difference (P Value)		Order of Integration
	Intercept	Trend &Intercept	Intercept	Trend & Intercept	
Ln_IMR	0.9994	0.6069	0.0444**	0.0507**	I(1)
Ln_Women_edu	0.0069	0.0519	0.0243**	0.0047***	I(1)

The table presents the results of unit root tests for Ln_IMR (log of Infant Mortality Rate) and Ln_Women_edu (log of women's enrolment in higher education) to determine their stationarity. The P-values for both variables in levels are high, indicating non-stationarity, except for Ln_Women_edu under the intercept-only case, which is marginally stationary (P = 0.0069). After taking the first difference, both variables have significant P-values below 0.05, confirming stationarity at first difference. Thus, both Ln_IMR and Ln_Women_edu are integrated of order 1 (I(1)), indicating that they become stationary after first differencing. This suggests non-stationarity in their level form but stationarity in their first differences.

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Cointegration Test

Since both Ln_IMR and Ln_Women_edu are non-stationary at their levels but achieve stationarity after first differencing, it is essential to test for a long-run equilibrium relationship (Johansen, S. 1988). A cointegration test determines whether these variables move together over time, despite being non-stationary, suggesting the possibility of a stable, long-term relationship. The cointegration test confirms whether the observed relationship is valid and not simply due to a common time trend in the series. Identifying cointegration helps ensure that the relationship is meaningful and not spurious (Enders, W.,2014). Before implementing the cointegration test, determining the appropriate lag length for the variables is essential. The Akaike Information Criterion (AIC) has been employed for this purpose, and the results indicate that the correct lag length for the variables is 2. This ensures that the dynamics of the time series are appropriately captured, leading to more accurate and reliable results in the subsequent cointegration analysis.

Table 2: Cointegration Test Statistics

Variables	Hypothesis No. of CE(s)	A Trace Test Statistics	Critical Value for % confidence interval
Ln_IMR and Ln_Women_Edu	None	19.70912	25.87211 (0.2410)
	Atmost 1	4.812403	12.51798 (0.6235)

The Johansen cointegration test results indicate no significant long-term relationship between women's higher education enrollment and the Infant Mortality Rate. Both hypotheses indicate that the variables do not share a stable long-term relationship. As a result, subsequent analyses may focus on short-term dynamics or alternative relationships between the variables, as the lack of cointegration implies that the variables may not move together over time in a predictable manner.

Vector Autoregressive Analysis

Since the Johansen cointegration test results show no long-term equilibrium relationship between the variables (Ln_IMR and Ln_Women_Edu), the next step is to focus on the short-term dynamics. Therefore, a Vector Autoregressive (VAR) analysis will be employed.

Table 3: Vector Autoregressive Test Statistics

Variables	Ln_IMR (T-Statistics)	Ln_Women_Edu (T-Statistics)
Ln_IMR(-1)	8.74102 (2.06010)	0.115357 (0.41343)
Ln_IMR(-2)	-0.291233 (-0.60650)	-498655 (-1.06577)
Ln_Women_Edu(-1)	-0.664745 (-1.44685)	0.213140 (0.47611)
Ln_Women_Edu(-2)	0.171918 (0.45606)	0.323992 (1.62016)

The VAR analysis shows that the first lag of Ln_IMR (log of Infant Mortality Rate) significantly positively influences the current Ln_IMR, with a coefficient of 0.8741 and a t-statistic of 2.06, suggesting strong autocorrelation. The second lag of Ln_IMR is not significant (coefficient: -0.2912, t-statistic: -0.61). Neither the first nor second lags of Ln_Women_Enrolment significantly affect Ln_IMR, with coefficients of -0.6647 (t-statistic: -1.45) for the first lag and 0.1719 (t-statistic: 0.46) for the second lag. When Ln_Women_Enrolment is the dependent variable, neither the lags of Ln_IMR nor Ln_Women_Enrolment are significant. For Ln_IMR(-1), the coefficient is 0.1154 (t-statistic: 0.28), and for Ln_IMR(-2), it is -0.4987 (t-statistic: -1.07). Similarly, both lags of Ln_Women_Enrolment are insignificant, with coefficients of 0.2131 (t-statistic: 0.48) and 0.3240 (t-statistic: 0.88). Overall, the results suggest no significant short-term connection between women's higher education enrolment and infant mortality, with IMR being influenced primarily by its past values.

CONCLUSION

This study examined the link between women's enrollment in higher education and the Infant Mortality Rate (IMR) in India over the period from 2011 to 2022.. Despite a growing body of literature suggesting that women's education can positively impact health outcomes, particularly maternal and child health, the findings from the VAR analysis indicate no significant short-term relationship between women's higher education enrolment and IMR. The analysis revealed that the past values of IMR have a strong influence on current IMR, while the lags of women's enrolment in higher education did not show any statistically significant effects on either

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IMR or women's current enrolment. These results highlight the rigidity of the relationship between education and health outcomes, suggesting that while women's education is essential for broader societal development, its direct impact on reducing infant mortality may be mediated by other factors, such as healthcare access, socioeconomic conditions, and public health initiatives. Therefore, further research is needed to explore these mediating factors and the potential long-term benefits of investing in women's education on public health outcomes. Ultimately, this study highlights the importance of a multifaceted approach to improving maternal and child health in India, integrating education with healthcare and social support systems.

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