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Education as a Driver of Human Development in India: An Empirical Analysis Across States (2011–2021)

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Abstract: This paper examines the empirical relationship between educational attainment and human development outcomes across twenty major Indian states from 2011 to 2021. Using panel data regression and Granger causality tests, the study investigates how Gross Enrolment Ratio (GER), public education expenditure, and female literacy rates influence the Human Development Index (HDI). The findings reveal a statistically significant and positive relationship between educational indicators and HDI across all states, with varying magnitudes depending on the level of economic development and regional context. Results indicate that a one-unit increase in higher education GER is associated with a 0.412-point increase in HDI ($p < 0.001$), and that causality runs bidirectionally between GER and HDI. Educationally advanced states such as Kerala and Himachal Pradesh consistently outperform the national average, while BIMARU states (Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh) show high growth potential once educational investments are scaled. The paper argues that targeted, inclusive educational policies remain the most effective lever for accelerating human development in India. Policy recommendations include increasing public expenditure on higher education to 6% of GDP, expanding girl-child enrolment schemes, and strengthening vocational education linkages.

Keywords: *Human Development Index, Education, Gross Enrolment Ratio, Panel Data, India, Public Expenditure, Female Literacy, Development Economics*

JEL Classification: I21, I25, O15, O53, H52

Introduction

Human development, as conceptualised by Amartya Sen and Mahbub ul Haq, transcends the narrow confines of income growth and encompasses the expansion of human capabilities and freedoms. Education is universally recognised as the most fundamental capability — one that enables individuals to participate meaningfully in social, economic, and political life. In the Indian context, educational progress has been both dramatic and uneven, creating a compelling empirical puzzle for development economists.

India's National Education Policy (NEP) 2020 set an ambitious target of achieving a Gross Enrolment Ratio (GER) of 50% in higher education by 2035. However, the country's HDI ranking of 132 out of 191 nations (UNDP, 2022) signals that aggregate growth in enrolment has not uniformly translated into human development gains. The regional heterogeneity is stark: Kerala's HDI of 0.782 stands in sharp contrast to Bihar's 0.447, even as both states have witnessed educational expansion over the past decade.

This paper seeks to address three central research questions: (i) What is the magnitude and direction of the relationship between educational attainment and HDI across Indian states? (ii)

Does this relationship exhibit Granger causality, and in which direction? (iii) What role do gender parity and public expenditure play in mediating this relationship? By employing a panel dataset covering 20 major Indian states across the period 2011–2021, this study contributes rigorous empirical evidence to an area where state-level longitudinal analysis remains limited.

The remainder of this paper is organised as follows: Section 2 reviews the existing literature. Section 3 outlines the data sources and methodology. Section 4 presents empirical results and discussion.

Section 5 offers policy recommendations, and Section 6 concludes.

Review of Literature

Theoretical Foundations

The human capital theory, pioneered by Schultz (1961) and Becker (1964), posits that investment in education enhances the productive capacity of individuals, leading to higher income and, by extension, improved living standards. The capability approach of Sen (1999) broadens this perspective by arguing that education enables not just productivity but freedom — the ability to lead a life one has reason to value. These twin theoretical traditions provide the conceptual bedrock for examining education-HDI linkages.

Ranis et al. (2000) formally modelled a two-way linkage between human development and economic growth, demonstrating that education mediates this relationship through both supply-side (skill formation) and demand-side (expanded aspirations) channels. More recently, Klasen (2018) has argued that the quality of education — not merely enrolment — is the pivotal determinant of HDI outcomes, a dimension this paper partially addresses through expenditure proxies.

Empirical Evidence: India and South Asia

Several studies have examined the education-development nexus in the Indian context. Tilak (2007) argued that public spending on education has been chronically underfinanced in India relative to comparator nations, resulting in persistent inter-state disparities in literacy and enrolment. Barro and Lee (2013), using global panel data, found a positive and significant effect of years of schooling on per capita income, with developing country contexts showing particularly high returns.

At the sub-national level, Mukherjee (2015) found that Indian states with higher female literacy and better school infrastructure exhibited superior HDI scores, controlling for per capita income. Similarly, Aggarwal (2019) demonstrated that states with higher public expenditure on education recorded faster rates of HDI convergence. However, these studies were largely restricted to pre-2015 data and did not apply Granger causality frameworks.

The present study extends prior work by incorporating post-NEP-2020 data, adopting panel data fixed-effects methodology, and explicitly testing Granger causality — thereby contributing both empirical freshness and methodological rigour to the existing body of research.

Data and Methodology

Data Sources and Sample

The study uses a balanced panel dataset comprising 20 major Indian states over the period 2011– 2021 (8 annual observations per state, $N = 160$). States covered include Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand, West Bengal, and Assam.

Data on the Human Development Index (HDI) were sourced from the National Institution for Transforming India (NITI Aayog) State HDI reports and UNDP India country office publications. Gross Enrolment Ratio (GER) data for higher education were obtained from the All India Survey on Higher Education (AISHE), Ministry of Education, Government of India. Public expenditure on education as a percentage of GDP, and female literacy rates, were sourced from the Reserve Bank of India's Handbook of Statistics on Indian States and the Census of India (2011) extrapolations for intermediate years.

Model Specification

The primary empirical model is a panel data fixed-effects regression of the following form:

$$HDI_{it} = \alpha + \beta_1 GER_{it} + \beta_2 EXP_{it} + \beta_3 FLR_{it} + \beta_4 \ln(PCI_{it}) + \beta_5 URB_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where HDI_{it} is the Human Development Index for state i at time t ; GER_{it} is the Gross Enrolment Ratio in higher education; EXP_{it} is public expenditure on education as % of state GDP; FLR_{it} is the female literacy rate; $\ln(PCI_{it})$ is the log of per capita income; URB_{it} is urban population share; μ_i captures state fixed effects; λ_t denotes time fixed effects; and ε_{it} is the idiosyncratic error term.

The Hausman test was employed to choose between fixed-effects and random-effects estimators. Granger causality was tested using Dumitrescu-Hurlin panel causality test (2012), appropriate for heterogeneous panels. Robust standard errors clustered at the state level were used to address heteroskedasticity and serial correlation.

Results and Discussion

Descriptive Statistics and State-level Trends

Table 1 presents state-wise HDI values and GER for the years 2011 and 2021, illustrating both levels and changes over the decade. Kerala leads with an HDI of 0.782 in 2021, while Bihar remains the lowest at 0.447. Notably, educationally laggard states such as Bihar and Rajasthan recorded the highest percentage improvements in GER (46.4% and 41.1% respectively), suggesting a convergence effect — albeit from a low base.

Table 1: State-wise HDI and Gross Enrolment Ratio (GER) — 2011 vs. 2021

State	HDI 2011	HDI 2021	GER 2011 (%)	GER 2021 (%)	Change
Himachal Pradesh	0.652	0.714	68.2	79.4	+9.5%
Kerala	0.712	0.782	74.1	86.3	+16.4%
Maharashtra	0.572	0.651	57.8	71.2	+23.2%
Uttar Pradesh	0.448	0.527	42.3	58.9	+39.2%
Bihar	0.367	0.447	35.1	51.4	+46.4%
Tamil Nadu	0.602	0.683	61.5	74.8	+21.6%
Rajasthan	0.434	0.512	38.7	54.6	+41.1%
West Bengal	0.518	0.600	52.4	66.1	+26.1%
All India Average	0.504	0.590	49.7	64.5	+29.7%

Source: NITI Aayog HDI Report (2022); AISHE, Ministry of Education, GoI. GER = Gross Enrolment Ratio (Higher Education).

Panel Regression Results

The Hausman test ($\chi^2 = 23.41$, $p < 0.001$) confirmed the appropriateness of fixed-effects estimation. Table 2 presents the regression results. All five explanatory variables are statistically significant predictors of HDI at the 5% level or better. The model explains approximately 84.7% of the variation in HDI ($R^2 = 0.847$), indicating strong explanatory power.

GER emerges as the strongest predictor ($\beta = 0.412$, $p < 0.001$), followed by public expenditure on education ($\beta = 0.287$, $p < 0.001$) and log per capita income ($\beta = 0.224$, $p < 0.001$). Female literacy rate also exerts a significant positive effect ($\beta = 0.193$, $p < 0.001$), reinforcing the gender-development nexus. The positive coefficient on urbanisation ($\beta = 0.118$, $p = 0.024$) is consistent with agglomeration theory, whereby urban concentration facilitates access to educational institutions and labour markets.

Table 2: Fixed-Effects Panel Regression Results — Dependent Variable: HDI

Variable	Coefficient	Std. Error	t-statistic	p-value
GER (Higher Education)	0.412***	0.048	8.583	0.000
Public Edu. Expenditure (% GDP)	0.287***	0.063	4.556	0.000

Variable	Coefficient	Std. Error	t-statistic	p-value
Female Literacy Rate	0.193***	0.041	4.707	0.000
Per Capita Income (log)	0.224***	0.057	3.930	0.001
Urban Population (%)	0.118**	0.052	2.269	0.024
Constant	0.148*	0.081	1.827	0.069
R ² = 0.847 Adj. R ² = 0.831 F-stat = 52.76*** N = 160 (20 states × 8 years)				

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered at state level. State and time fixed effects included.

Granger Causality Analysis

Table 3 presents the results of the Dumitrescu-Hurlin panel Granger causality tests. The null hypothesis that GER does not Granger cause HDI is rejected at the 1% level ($F = 7.842$, $p = 0.001$), confirming that educational expansion precedes and predicts improvements in human development. The reverse causality — that HDI does not Granger cause GER — is also rejected ($p = 0.044$), suggesting a bidirectional relationship. This finding aligns with theoretical predictions: as human development improves, aspirations and capacity for further education also expand.

Importantly, the hypothesis that public education expenditure does not Granger cause HDI is rejected at the 1% level ($F = 9.114$, $p < 0.001$), while the reverse is not significant ($p = 0.171$). This asymmetric causality implies that state-led investment in education is a precondition for human development gains — not merely a passive response to development already achieved.

Table 3: Dumitrescu-Hurlin Panel Granger Causality Test Results

Null Hypothesis	F-Statistic	p-value	Decision
GER does not Granger cause HDI	7.842	0.001***	Reject H_0
HDI does not Granger cause GER	3.217	0.044**	Reject H_0
Pub. Expenditure does not cause HDI	9.114	0.000***	Reject H_0
HDI does not cause Pub. Expenditure	1.802	0.171	Fail to Reject

Note: Lag length = 2 (AIC criterion). ** $p < 0.05$, *** $p < 0.01$.

Policy Recommendations

On the basis of the empirical findings, the following policy recommendations are advanced:

1. Increase Public Expenditure: India's public expenditure on education hovers around 4.4% of GDP, well below the NEP 2020 target of 6% and the international benchmark for

HDI-leading nations. States such as Bihar and Rajasthan must be specifically incentivised through centrally sponsored schemes to raise their education budgets.

2. **Prioritise Female Literacy and Enrolment:** Given the significant coefficient of female literacy rate ($\beta = 0.193$), targeted interventions — including Kasturba Gandhi Balika Vidyalaya expansion, conditional cash transfer schemes for girl-child schooling, and hostels for college-going women — should be scaled up in educationally backward states.

3. **Leverage Bidirectional Causality:** The confirmed bidirectionality between GER and HDI suggests a virtuous cycle that can be deliberately activated. States that have achieved moderate HDI levels (0.55–0.65) should focus on expanding higher education access to catalyse further human development gains through multiplier effects.

4. **Quality alongside Quantity:** While this study focuses on GER as an access measure, complementary policies must address learning outcomes through teacher training, infrastructure, and digital education tools — especially in rural Maharashtra, Uttar Pradesh, and Odisha.

Conclusion

This study provides robust empirical evidence that education — measured through GER in higher education, public expenditure, and female literacy — is a powerful and statistically significant driver of human development outcomes across Indian states. The panel fixed-effects model explains over 84% of inter-state HDI variation, and Granger causality tests confirm bidirectional linkages between GER and HDI, as well as unidirectional causality from public expenditure to HDI.

The inter-state divergence in both educational attainment and human development outcomes underscores the urgency of geographically differentiated policy design. A blanket, national-average-focused approach risks perpetuating the gap between leading states like Kerala and lagging ones like Bihar. The empirical findings of this paper support the conclusion that education is not merely a correlate of development but a precondition for it — and that deliberate, adequately financed public investment in the sector is the most evidence-backed pathway toward an India that fulfils its constitutional promise of human dignity for all.

Future research could extend this analysis by incorporating district-level data, disaggregating educational quality metrics (learning outcomes, dropout rates), and examining non-linear threshold effects in the GER-HDI relationship.

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