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RESEARCH PAPER

Interlinkages between Population Growth and Educational Development in Bihar: A Socioeconomic Analysis

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ABSTRACT

Population growth remains one of the critical challenges to socioeconomic development, particularly in India's poorer states such as Bihar. This study examines the socioeconomic determinants of population growth in Bihar and its implications for educational development. Using secondary data from Census reports (1951–2011), district handbooks and government surveys, the research employs statistical and cartographic techniques including Z-Score analysis and Karl Pearson's coefficient of correlation to assess district level variations in population growth and literacy rates. Bihar's population growth rate (25.42% in 2011) far exceeds the national average (17.70%), while its literacy rate (61.8%) lags significantly behind (74.04%). The findings reveal a strong positive correlation between population growth and literacy at the state level (r = +0.8003, significant at 95%) and a moderate negative correlation at the district level (r = –0.636, significant at 99%), underscoring complex interdependencies between demographic expansion and education. Spatial analysis highlights stark intra state disparities, with northern districts showing high population growth and low literacy, contrasting with better performing southern districts. The study concludes that rapid population growth adversely affects educational accessibility and quality, emphasizing the need for balanced infrastructural investment, regional equity and strengthened educational policies to curb demographic pressure and foster sustainable development in Bihar.

Keywords: *Population growth, Literacy rate, Socioeconomic determinants, Educational inequality, Bihar, Z-score analysis, Correlation analysis, Demographic transition, Spatial disparities, Educational development*

INTRODUCTION

Overpopulation is one of the major factors contributing too many of the world's pressing issues. It influences every aspect of life from food shortages and lack of clean drinking water to the depletion of energy resources and challenges within the education system all of which are vital for modern society. Population growth, or the increase in population size, brings about significant changes not only in culture, traditions and behavior but also in the standard of education. In developing countries such as India, particularly in the state of Bihar, rapid population growth has been found to reduce educational opportunities for children. Bihar's population has been increasing steadily, with a decadal growth rate of 25.42 percent in 2011, compared to the national average of 17.70 percent.

Despite India's efforts to provide equitable education for all students, regardless of caste, creed, or religion, the demographic transition marked by declining fertility and mortality rates has led to a growing youth population that must be equipped with proper education to become productively employed. Smaller family sizes often allow better educational access and can encourage education for girls, as those from larger families with limited resources are less likely to attend school. Thus, a high population growth rate remains a major obstacle to the development of the education system in Bihar.

Studies on population dynamics have consistently shown a strong relationship between education and demographic factors, particularly population growth. Education plays a vital role in shaping society, creating skilled manpower and fostering awareness of social, cultural and political issues. However, Bihar's education system has suffered greatly from persistent population increases - the state's growth rate has remained above 20 percent since 1971, even as the national average has

declined. The rapid rise in the number of school age children has created a constant demand for more schools, teachers and resources such as books and learning materials demands that remain difficult to meet in a state with limited educational infrastructure.

When examining the challenges in Bihar's education system, it is impossible to ignore the effects of population growth. The increasing number of students requires the establishment of new schools and the expansion of facilities, which affects not only students and teachers but also curricula and teaching methods. Students vary widely in their interests and intellectual abilities, necessitating diverse educational options. Therefore, in addition to traditional government schools, alternative types of institutions are needed. However, providing quality education to all remains an immense challenge in Bihar due to the rapidly growing population, suggesting a direct link between population growth and educational attainment.

According to the 2011 Census, Bihar's literacy rate stood at 61.8 percent, significantly lower than the national average of 74.04 percent. The All India Survey on Higher Education (AISHE) also revealed a striking gender imbalance among teachers, with a female to male ratio of 1:4 only 24.7 percent being women. The state's educational infrastructure is inadequate and poorly matched to its needs. Once home to the world renowned Nalanda University, Bihar's education system has declined sharply, with low enrollment rates and high dropout levels, particularly among girls. Indicators such as the Educational Development Index, College Population Index for Professional Education (2001–02), Gross Enrolment Ratio (2009–10) and Gender Parity Index (2009–10) all place Bihar among the lowest ranked states (Jiyaur Rahman, Educational Infrastructure and Education in Bihar).

Data from NITI Aayog shows only a marginal improvement in Bihar's educational performance- a 7.3 percent rise in 2016–17 compared with 30 percent in 2015–16 placing it as the second lowest in India's School Education Quality Index (SEQI), just above Jharkhand. Moreover, as India's sixth poorest state, Bihar spends the least amount per student, according to an IndiaSpend analysis of Government of India data.

OBJECTIVES OF THE STUDY

The primary objectives of this research are as follows:

1. To examine the trend of population growth and literacy rates in India and Bihar from 1951 to 2011 and to evaluate their correlation and statistical significance.
2. To study the spatial variations in population growth and literacy rates at the district level for the year 2011.
3. To assess the spatial disparities in variables associated with educational levels and to determine the overall level of education using the Z-Score statistical method.
4. To explore the relationship between population growth and seventeen education related variables including literacy rate and to test the strength and significance of these relationships with respect to the level of education in Bihar.

DATABASE AND METHODOLOGY

This study is primarily based on secondary data sources. Relevant data have been collected from various Census Reports, *District Census Handbooks* of all districts in Bihar, the official website of the *Office of the Registrar General and Census Commissioner* (Ministry of Home Affairs, Government of India) and the *Economic Survey 2019–20* published by the Finance Department, Government of Bihar.

In this research, appropriate statistical and cartographic techniques including line graphs, bar graphs, the Z-Score method and Karl Pearson's coefficient of correlation have been employed to analyze the level of education, population growth, their interrelationship and the level of statistical significance at 95% and 99% confidence levels.

For analytical purposes, districts have been considered as the basic unit of study. The analysis of population growth variation is based on data from the 2011 Census, while data pertaining to the educational variables correspond to the period 2017–18, as this represents the most recent available information.

To assess the level of education at the district level in Bihar, seventeen independent variables have been selected, which includes, Seventeen independent variables have been selected for this study, which include: literacy rate (X_1), total enrolment in primary (X_2), total enrolment in upper primary (X_3), total enrolment of Scheduled Castes (SC) in primary (X_4), total enrolment of SC in upper primary (X_5), total enrolment of Scheduled Tribes (ST) in primary (X_6), total enrolment of ST in upper primary (X_7), number of primary schools (X_8), number of upper primary schools (X_9), number of teachers in primary schools (X_{10}), number of teachers in upper primary schools (X_{11}), coverage of MDMS (Class I–V) total enrolment (X_{12}), coverage of MDMS (Class I–V) per day (X_{13}), coverage of MDMS (Class VI–VIII) total enrolment (X_{14}), coverage of MDMS (Class VI–VIII) per day (X_{15}), number of affiliated colleges (X_{16}) and number of constituent colleges (X_{17}).
The dependent variable (Y) represents the Population Growth Rate.
The Z-Score values for the selected seventeen variables have been computed using the following formula:

$$Z = \frac{X - \bar{X}}{S}$$

where **Z** represents the standard score, **X** is the observed value, $\bar{X}$ is the mean of the variable and **S** denotes the standard deviation.
The formula indicates that the Z-score is calculated by subtracting the mean of the variable from its raw score and then dividing the result by the standard deviation of that variable. Furthermore, the Z-score values of all the selected variables were combined to derive a composite score for each district, which was used to evaluate the overall level of education in Bihar. Subsequently, the seventeen independent variables related to educational development in Bihar were correlated with the dependent variable population growth (2011) using Karl Pearson's coefficient of correlation and the significance of the relationship was tested at 95% and 99% confidence levels.
In addition, the analysis and interpretation regarding population growth and educational status have been supported through percentage calculations based on data collected from various secondary sources.

TRENDS OF POPULATION GROWTH AND LITERACY RATE IN INDIA & BIHAR (1951–2011)

Literacy rate plays a crucial role in influencing population growth. Generally, higher literacy levels are associated with improved living standards and developed nations with high literacy rates tend to experience lower population growth. There exists an inverse relationship between literacy and population growth greater literacy often leads to delayed marriages, shorter fertility periods and consequently, fewer children.
Since independence, both population growth and literacy have been major concerns for India. Although India became the first country to introduce a Family Planning Programme in 1952, it still remains the world's second most populous nation. Population growth is a complex process affected by multiple factors, but literacy especially female literacy remains one of the most significant. Education enables individuals to postpone marriage and childbirth, thus reducing family size.
Education serves as a fundamental requirement for the socio-economic development of both Bihar and India as a whole. However, Bihar's literacy rate remains unsatisfactory, ranking the lowest among Indian states. With a population of 104,099,452, Bihar is the third most populous state, following Uttar Pradesh (199,812,341) and Maharashtra (112,374,333). As per the 2011 Census, Bihar's literacy rate was 61.80%, considerably lower than India's national average of 74.04%. The state continues to have the largest number of illiterate people, primarily due to a fragile education system from the primary to higher education levels.
Despite several government initiatives such as scholarship programs, the Mid Day Meal Scheme, Samagra Shiksha Abhiyan and awareness campaigns promoting education progress has remained slow. The government has also provided free uniforms, textbooks and stationery to motivate parents to send their children to school. Yet, literacy levels in Bihar continue to lag behind other states. Deep rooted social and economic inequalities, gender and caste discrimination and a high population growth rate of 25.42% (compared to India's 17.70%) have further worsened the situation.

Since 1951, the literacy rate has steadily increased in both India and Bihar. Each decade witnessed at least a 10% rise in literacy, except in 1961 and 1991 when Bihar's literacy rates were 21.95% and 37.49%, respectively. Bihar's literacy rate improved from 13.49% in 1951 to 61.80% in 2011, showing an overall increase of 48.31 percentage points. The most significant rise occurred between 2001 and 2011, with a growth of 14.27 percentage points.

At the national level, the highest increase in literacy (12.63 percentage points) was recorded between 1991 and 2001, while Bihar's highest increase (14.27 points) occurred between 2001 and 2011. In 1951, India's literacy rate was 18.33%, while Bihar's was 13.49%, about 4.84 percentage points lower. By 1961, literacy rates rose to 28.3% in India and 21.95% in Bihar, marking gains of 9.97 and 8.46 points, respectively. In 1981, India achieved 43.57% literacy, up by 9.12 points from the previous decade, while Bihar recorded 32.32%, showing similar improvement (9.15 points) but still 11.25 points below the national average.

By 2001, India's literacy rate rose to 64.84%, while Bihar's stood at 47.53%, a gap of 17.31 points. In 2011, India's literacy rate increased to 74.04% (a 9.2 point rise from 2001), while Bihar's climbed to 61.8%, which was 12.24 points below the national average but 14.27 points higher than its own 2001 figure.

When comparing literacy rates with population growth, it is evident that Bihar has consistently recorded a higher growth rate. In 2011, Bihar's population growth reached 25.42%, while India's overall growth declined to 17.70%, continuing its downward trend since 1981 (24.66%). Between 1951 and 2011, Bihar's growth rate rose from 10.58% to 25.42%, an increase of 14.84 percentage points, compared to India's modest rise from 13.31% to 17.70% (only 4.39 points). Bihar, accounting for 8.6% of India's total population, has shown a persistently high growth rate since 1951, with minor declines observed in 1991 (by 0.78 points) and 2011 (by 3.2 points). The sharpest rise in Bihar's population occurred between 1951 and 1961, increasing from 10.58% to 19.79% (a jump of 9.21 points). Similarly, India registered its highest growth during this period, rising from 13.31% to 21.51% (an increase of 8.2 points).

This rapid growth during the 1951–1961 decade may be attributed to improvements in trade, transportation, employment opportunities, healthcare and education, which enhanced living conditions and reduced mortality rates, leading to accelerated natural population growth.

To understand the relationship between population growth and literacy, the Karl Pearson's coefficient of correlation method was applied. In this analysis, literacy rate was treated as the independent variable and population growth as the dependent variable. The results reveal a high positive correlation in Bihar, with a coefficient value of +0.8003 (indicating strong correlation between +0.75 and +1.00) and a P value of 0.0306, significant at the 95% confidence level. In contrast, for India, a low positive correlation was observed, with a coefficient of +0.1718 and a P value of 0.7126, which is statistically insignificant.

SPATIAL VARIATION IN POPULATION GROWTH AND LITERACY RATE

Bihar has consistently recorded a high population growth rate from 1951 to 2001, except during the 1991 Census when the rate fell by 0.78% compared to 1981. The 2011 Census again showed a decline of 3.2 percentage points from the previous decade. However, district level data reveal notable spatial variations in population growth. In 2011, none of Bihar's 38 districts recorded a population growth rate below the national average of 17.70%. In fact, 22 districts exceeded the state average of 25.42%. Madhepura registered the highest growth rate of 31.12%, followed by Kishanganj (30.40%), Araria (30.25%), Khagaria (30.19%) and East Champaran (29.43%).

Madhepura, despite having the highest population growth, recorded a literacy rate of only 52.25% in 2011 almost 9.55 percentage points lower than the state average of 61.80%. Similarly, Kishanganj (55.46%), Araria (53.53%) and Khagaria (57.92%) also had literacy rates below the state average, clearly indicating an inverse relationship between literacy and population growth. The lowest population growth was recorded in Gopalganj (19.02%), followed by Arwal (19.23%) and Darbhanga (19.47%), all of which had higher than average literacy rates 65.47% and 67.43%, respectively highlighting literacy's role in population control.

When classified by growth levels, three districts (Gopalganj, Arwal and Darbhanga) fall under the low growth category (below 20%), twelve districts such as Patna, Nalanda and Bhojpur show

moderate growth (20.01–25%), nineteen districts including Muzaffarpur, Samastipur and Katihar record high growth (25.01–30%) and four districts Madhepura, Kishanganj, Araria and Khagaria show very high growth (above 30%), all located in North Bihar plain.

Literacy, which reflects the ability to read and write with understanding, significantly influences the socio-economic development and fertility patterns of a region. Bihar remains the least literate state in India, with a literacy rate of 61.8% in 2011, though it improved markedly from 47.53% in 2001 due to initiatives like *Sarva Shiksha Abhiyan*. Out of 104 million people, about 52.5 million are literate, but female literacy remains low (51.50%), largely due to poverty, gender bias and poor educational infrastructure. The state's education budget reached a record ₹34,798.69 crore in 2019–20, yet challenges persist.

According to the 2011 Census, 22 districts recorded literacy rates above the state average. Rohtas (73.37%) ranked highest, followed by Patna (70.68%), Bhojpur (70.47%), Munger (70.46%) and Aurangabad (70.32%). All these high literacy districts, located in South Bihar, also recorded relatively low population growth (below 25%), except Aurangabad (26.28%). Rohtas, known as the "rice bowl" of Bihar, had strong educational infrastructure with over 1,500 primary schools, 1,000 upper primary schools and nearly 6,000 teachers.

In contrast, Purnea, with the lowest literacy rate (51.08%), showed a very high population growth (28.33%). Although it had more students and teachers than Rohtas, it lagged in the number of schools. Based on literacy, Bihar's districts can be categorized as follows: 17 districts below 60% (low literacy), 8 districts between 60–65% (moderate), 7 districts between 65–70% (high) and 6 districts above 70% (very high). Notably, the six districts with literacy rates above 70% Patna, Bhojpur, Buxar, Rohtas, Munger and Aurangabad are all in South Bihar and surpass the national literacy average of 70.04%.

LEVELS OF EDUCATION

Education imparts knowledge, skills and values that make individuals responsible towards family, society and the nation. It broadens our understanding of the world and enables us to fight corruption and injustice. For any region's progress, education plays a crucial role, as areas with higher literacy rates tend to be more developed and better equipped with infrastructure.

Education bridges social gaps through the exchange of knowledge, culture and values. A well educated society nurtures a capable younger generation, reduces poverty, empowers women, generates employment and improves the overall economy.

Bihar, once an ancient center of learning with institutions like Nalanda and Vikramshila, now faces serious educational challenges. According to the NITI Aayog (2019), Bihar ranked second lowest in the School Education Quality Index. Nearly 40% of teaching positions in government schools remain vacant and a NUEPA survey found that only 21% of primary teachers had completed 10th grade. Despite these issues, the education system is improving steadily.

The government has launched several schemes Sarva Shiksha Abhiyan, Kasturba Gandhi Balika Vidyalaya, Mukhya Mantri Samagra Vidyalaya Vikas Yojana and Poshak Yojana to enhance accessibility and quality. The Bihar Education Project Council (1991) aims to provide universal elementary education, especially for marginalized groups.

Bihar's education system is structured into primary, upper primary, secondary and senior secondary levels. The literacy rate improved from 47.53% in 2001 to 61.80% in 2011, reflecting progress through the expansion of schools and teachers under Sarva Shiksha Abhiyan. According to the Bihar Economic Survey (2019–20), there were 42,932 primary and 31,074 upper primary schools in 2017–18. Patna, East Champaran and Muzaffarpur had the highest numbers of schools, while Sheohar and Arwal recorded the lowest.

There are 1.77 lakh primary school teachers, with Patna and Siwan having the highest share. Districts with better school and teacher availability, such as Patna, Gaya and Muzaffarpur, also have higher literacy rates. Enrolment figures show 137.71 lakh children in primary and 96.03 lakh in upper primary schools, with a significant share of SC and ST students. The Mid Day Meal Scheme has boosted attendance, especially among children from poor families.

Bihar also has 504 affiliated and 277 constituent colleges, with Patna leading in numbers. However, a z-score analysis of 17 educational indicators revealed wide inter district disparities. Only four

districts Patna, Gaya, East Champaran and Muzaffarpur, showed positive scores, highlighting the uneven distribution of educational infrastructure and teacher student ratios across the state.

To sustain progress, Bihar must focus on increasing the number of classrooms, teachers and essential facilities such as drinking water and sanitation particularly for girls to ensure inclusive and quality education for all.

CORRELATION

A simple correlation analysis was conducted to examine the association between population growth (dependent variable) and seventeen independent variables, assuming that some degree of relationship exists among them. The selection of these variables was based on their logical and theoretical link with population growth.

Karl Pearson's coefficient of correlation was applied to measure these relationships and the results were tested at 99% and 95% levels of significance. Correlation matrices were prepared to identify relationships among all variables and to compare their strength and direction.

The analysis reveals a moderate negative correlation (-0.636) between population growth rate and literacy rate, which is significant at the 99% confidence level. Similarly, the number of affiliated colleges (-0.220) and constituent colleges (-0.162) also show negative correlations, though both are statistically insignificant.

Of the seventeen variables, fourteen show positive correlations with population growth rate. Among them, total student enrolment under the Mid Day Meal scheme has a moderate positive correlation (+0.318), significant at the 95% level. The enrolment of ST children in both primary (+0.282) and upper primary schools (+0.280) also shows moderate but insignificant positive correlations. Coverage of the Mid Day Meal per day in classes I–V displays a relatively high positive correlation (+0.296), though it is also not significant.

Overall, most variables show statistically significant relationships at the 99% confidence level, indicating a complex but meaningful association between population growth and key socio-educational indicators.

CONCLUSION

Bihar's population has been steadily increasing, recording a growth rate of 25.42% in 2011, compared to 17.70% for India overall. Although the growth rate declined slightly in 1991 and 2011, the overall rise since 1951 remains substantial. This growing population poses a major challenge for Bihar in maintaining an effective education system that ensures equal access for all, regardless of caste, religion, or economic background.

Providing quality education to such a large number of school age children is difficult due to limited economic resources. The shortage of teachers, classrooms and schools has resulted in overcrowded institutions and migration of students to other states. To reduce this outflow, Bihar must expand its educational infrastructure, recruit more teachers and reduce the student–teacher ratio. Overpopulation continues to be a key barrier to educational progress.

While the literacy rate has improved from 13.49% in 1951 to 61.80% in 2011, Bihar still ranks lowest among all Indian states. Correlation analysis shows a strong positive relationship ($r = +0.8003$) between population growth and literacy rate, significant at the 95% level, suggesting that population expansion directly affects educational development.

District level analysis highlights significant intra state disparities. Northern districts such as Madhepura, Kishanganj, Araria, Khagaria and East Champaran report higher population growth and lower literacy rates, while southern districts like Rohtas, Patna, Bhojpur, Munger and Aurangabad perform better educationally.

Composite Z-score evaluation indicates that only Patna, Gaya, East Champaran and Muzaffarpur have above average educational development, reflecting relatively better infrastructure. Karl Pearson's correlation further shows a moderate negative relationship (-0.636) between population growth and literacy rate, significant at the 99% level, while other educational indicators exhibit mixed correlations most being positive but statistically insignificant.

In summary, Bihar's high population growth continues to hinder educational advancement. Balanced regional development, investment in infrastructure and improved quality of schooling are essential to strengthen the state's education system and ensure equitable progress.

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