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Educational and Health Indicators as Measures of Development in the North Bihar Region: A Comparative Geographical Assessment

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ABSTRACT

Education and health are two central pillars of human development because they determine the productive capacity, social mobility and long-term welfare of a population. The present study examines the comparative development status of three important North Bihar districts—Darbhanga, Madhubani and Samastipur—through selected educational and health indicators. The study is based mainly on secondary data drawn from Census 2011, NFHS-5-based district nutrition profiles, HMIS-linked district demographic estimates and official education and development reports. A composite development index is constructed through min–max normalization using literacy, female literacy, institutional delivery, child stunting, wasting, underweight, child anaemia and women's anaemia indicators. The analysis shows that Samastipur records the highest composite score because of relatively better literacy and institutional delivery performance, while Madhubani occupies the middle position due to comparatively better child nutrition indicators but weaker anaemia outcomes. Darbhanga remains the most constrained among the three districts, particularly in female literacy and institutional delivery coverage. The study argues that development in North Bihar is not merely a question of income or infrastructure but of human capability formation through education, maternal health, child nutrition and gender-sensitive public service delivery.

Keywords: North Bihar, human development, literacy, health indicators, composite index, Darbhanga, Madhubani, Samastipur.

I. INTRODUCTION

The measurement of development has gradually moved beyond income-centred indicators toward a broader human development approach. Education and health are now treated as foundational dimensions of development because they directly influence labour productivity, demographic transition, gender equality, social participation and intergenerational mobility [1]. In regions such as North Bihar, where agrarian livelihoods, rural settlement patterns, flood-prone ecology and social inequalities shape everyday life, educational and health indicators provide a more meaningful assessment of development than per capita income alone. The Human Development Reports of UNDP have repeatedly emphasized that literacy, life expectancy, schooling and access to basic health services are central to the expansion of human capabilities [1].

Bihar has historically remained one of India's more developmentally challenged states, although public investment in roads, school enrolment, health outreach and social protection has improved many indicators in recent decades [2]. North Bihar presents a distinct geographical and socio-economic context. The region is densely populated, largely rural, vulnerable to recurrent floods and marked by high dependence on agriculture, migration and informal employment. Darbhanga, Madhubani and Samastipur are located in the Mithila cultural region and share several common features, including high rural density, agrarian livelihoods, linguistic-cultural continuity and dependence on public-sector delivery systems.

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Yet these districts do not show identical outcomes in education and health. A comparative geographical assessment is therefore useful for identifying intra-regional development differences.

The Census 2011 data show that Madhubani had a population of 4,487,379, literacy rate of 58.62 percent and female literacy of 46.16 percent, while Samastipur recorded a population of 4,261,566, literacy rate of 61.86 percent and female literacy of 51.51 percent [3], [4]. Darbhanga recorded a population of 3,937,385, sex ratio of 910 females per 1000 males and literacy rate of 56.56 percent according to Census-based district sources [5]. These figures show that even neighbouring districts within the same cultural-geographical region differ in educational progress. The difference becomes sharper when female literacy is considered, because female education is closely associated with maternal health behaviour, child nutrition, age at marriage, fertility decisions and household-level welfare [6].

Health indicators show a similarly uneven pattern. District Nutrition Profiles prepared using NFHS-4 and NFHS-5 data indicate that child stunting, wasting, underweight and anaemia remain major concerns across Darbhanga, Madhubani and Samastipur [7]–[9]. In Darbhanga, child stunting declined from 49 percent in 2016 to 45 percent in 2020, but child anaemia remained very high at 69 percent in 2020 [7]. In Madhubani, stunting declined from 52 percent to 43 percent and underweight declined from 45 percent to 36 percent, yet child anaemia increased from 63 percent to 71 percent [8]. In Samastipur, institutional delivery coverage was relatively high, but child wasting and underweight remained serious concerns, with wasting rising to 21 percent and underweight to 43 percent in 2020 [9]. These findings suggest that development in North Bihar must be studied through multidimensional indicators rather than through a single sectoral lens.

The present study attempts to measure the comparative development level of Darbhanga, Madhubani and Samastipur using selected education and health indicators. It uses secondary data and constructs a composite development index through statistical normalization. The main objective is not only to rank the districts but also to interpret how educational and health indicators interact with geographical and socio-economic conditions in the North Bihar region.

II. OBJECTIVES OF THE STUDY

The study has four main objectives. First, it examines educational development in Darbhanga, Madhubani and Samastipur through literacy and female literacy indicators. Second, it compares selected health indicators, particularly institutional delivery, child nutrition and anaemia. Third, it constructs a composite development index using normalized educational and health indicators. Fourth, it identifies district-specific development gaps and suggests policy measures for balanced human development in North Bihar.

III. DATA SOURCES AND METHODOLOGY

The study is based on secondary data. Educational indicators are taken mainly from Census 2011 and official district demographic sources. Health indicators are taken from District Nutrition Profiles prepared by IFPRI and NITI Aayog-linked sources using NFHS-4, NFHS-5, Census 2011 projected population and HMIS data [7]–[9]. The NFHS-5 Bihar report is used for wider state-level context because it provides district-level health and nutrition estimates and confirms the persistence of undernutrition, anaemia and maternal-child health challenges in Bihar [10]. UDISE+ is used as a background source for school education indicators and the institutional framework of school data reporting [11]. The SDG India Index

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methodology is used to justify the construction of a composite index based on normalized indicators [12].

The composite development index is calculated through the min–max normalization method. For positive indicators such as literacy, female literacy and institutional delivery, the formula used is:

$$I = \frac{X_i - X_{min}}{X_{max} - X_{min}} \times 100$$

For negative indicators such as stunting, wasting, underweight and anaemia, the formula is reversed:

$$I = \frac{X_{max} - X_i}{X_{max} - X_{min}} \times 100$$

The final composite index is the arithmetic mean of eight normalized indicators: literacy, female literacy, institutional delivery, low stunting, low wasting, low underweight, low child anaemia and low women's anaemia. Equal weights are used because the study treats education and health as jointly important human development dimensions. This approach follows the logic of multidimensional index construction used in human development and SDG monitoring exercises [1], [12].

IV. STUDY AREA: THE NORTH BIHAR CONTEXT

Darbhanga, Madhubani and Samastipur form a geographically contiguous cluster in North Bihar. The area lies within the middle Gangetic plain and is influenced by rivers, alluvial soils, high population density and a predominantly rural settlement structure. The districts belong to the larger Mithila region and share cultural features, but their developmental performance varies. Madhubani is known for its cultural heritage and rural craft economy; Darbhanga functions as an educational, medical and administrative centre for the wider region; Samastipur has important agricultural, dairy and transport linkages.

The geographical setting of these districts is developmentally significant. Floods, waterlogging, seasonal migration and dependence on smallholder agriculture affect both schooling continuity and health outcomes. Recurrent environmental stress often reduces household income stability and increases vulnerability among children and women. In such a context, education and health indicators become sensitive measures of development because they show whether public institutions are able to protect human capabilities despite geographical constraints.

V. EDUCATIONAL INDICATORS IN THE THREE DISTRICTS

Literacy is one of the most basic indicators of human development. It reflects the cumulative outcome of schooling access, household educational culture, gender norms and public investment. Census-based data show that Samastipur has the highest literacy rate among the three districts at 61.86 percent, followed by Madhubani at 58.62 percent and Darbhanga at 56.56 percent. Female literacy shows a wider gap: Samastipur records 51.51 percent, Madhubani 46.16 percent and Darbhanga about 44.33 percent [3]–[5]. This pattern suggests that Samastipur has a relative advantage in educational development, especially in gender-related educational outcomes.

Table 1. Educational and Demographic Indicators of Selected North Bihar Districts

District	Population, 2011	Literacy Rate (%)	Female Literacy (%)	Sex Ratio

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Darbhanga	3,937,385	56.56	44.33	910
Madhubani	4,487,379	58.62	46.16	926
Samastipur	4,261,566	61.86	51.51	911

Source: Compiled from Census 2011 and district demographic sources [3]–[5].

The gender gap in literacy is an important development concern. In North Bihar, female education has direct implications for maternal health, child nutrition and household-level decision-making. Studies on human development and gender have shown that women's education influences fertility behaviour, use of health services, immunization, nutrition practices and children's educational continuity [6], [13]. Therefore, the lower female literacy levels of Darbhanga and Madhubani are not merely educational concerns; they are also linked to health and social development.

VI. HEALTH INDICATORS AND DEVELOPMENT OUTCOMES

Health development in the region is assessed through maternal health, child nutrition and anaemia indicators. Institutional delivery is taken as a maternal health service indicator because it reflects access to health facilities, transport, awareness and public health outreach. The District Nutrition Profiles show that Darbhanga had 82,102 live births and 64,315 institutional births, giving an institutional delivery ratio of about 78.34 percent. Madhubani had 104,960 live births and 88,729 institutional births, giving a ratio of about 84.54 percent. Samastipur had 98,473 live births and 93,990 institutional births, giving a ratio of about 95.45 percent [7]–[9]. This makes Samastipur the strongest district in maternal service utilization among the three.

Child nutrition indicators present a more complex picture. In Darbhanga, 45 percent of children under five were stunted, 19 percent wasted, 39 percent underweight and 69 percent anaemic in 2020 [7]. In Madhubani, 43 percent were stunted, 17 percent wasted, 36 percent underweight and 71 percent anaemic [8]. In Samastipur, 44 percent were stunted, 21 percent wasted, 43 percent underweight and 67 percent anaemic [9]. Thus, Madhubani performs relatively better on stunting, wasting and underweight, but it has the highest child anaemia level. Samastipur has strong institutional delivery but weaker child wasting and underweight outcomes. This confirms that health development is multidimensional; better maternal service coverage does not automatically remove nutritional deprivation.

Table 2. Selected Health and Nutrition Indicators, 2020

District	Institutional Delivery Ratio (%)	Stunting Under 5 (%)	Wasting Under 5 (%)	Underweight Under 5 (%)	Child Anaemia (%)	Women Anaemia, Non-Pregnant (%)
Darbhanga	78.34	45	19	39	69	61
Madhubani	84.54	43	17	36	71	61
Samastipur	95.45	44	21	43	67	60

Source: Calculated and compiled from District Nutrition Profiles [7]–[9].

The coefficient of variation shows where inter-district inequality is sharper. Among the selected indicators, wasting has the highest coefficient of variation at about 8.59 percent, followed by institutional delivery at 8.21 percent and underweight at 7.29 percent. Female

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literacy also shows a relatively high coefficient of variation at 6.44 percent. This suggests that variation in North Bihar is most visible in maternal service utilization, acute malnutrition and female education. By contrast, women's anaemia has a very low coefficient of variation because all three districts show similarly high anaemia prevalence.

VII. COMPOSITE DEVELOPMENT INDEX

To compare overall human development conditions, the study constructs a composite index using eight indicators. Positive indicators are normalized directly, while negative indicators are reverse-normalized. The score ranges from 0 to 100, where a higher value indicates better relative development among the three districts.

Table 3. Normalized Composite Development Index

District	Education Score	Health Score	Composite Development Index	Rank
Samastipur	100.00	58.33	68.75	1
Madhubani	32.18	56.04	50.07	2
Darbhanga	0.00	26.19	19.64	3

Source: Author's calculation from Tables 1 and 2 using min–max normalization.

The composite index places Samastipur in the first position with a score of 68.75. Its high ranking is driven by better literacy, female literacy, institutional delivery and lower women's anaemia. However, Samastipur's child wasting and underweight indicators remain weak. Madhubani ranks second with a score of 50.07. Its performance is strengthened by comparatively lower stunting, wasting and underweight levels, but weakened by lower female literacy and high child anaemia. Darbhanga ranks third with a score of 19.64 because it has the lowest literacy, female literacy and institutional delivery performance among the three districts.

A correlation check between the education score and the health score gives a positive association of about 0.79. Although the number of districts is small and the result should not be treated as a formal causal estimate, it supports the broader argument that educational progress and health development tend to move together. Districts with better literacy, especially female literacy, are more likely to show better health service utilization and social awareness. This is consistent with the human capability approach, which views education and health as mutually reinforcing dimensions of development [1], [6], [13].

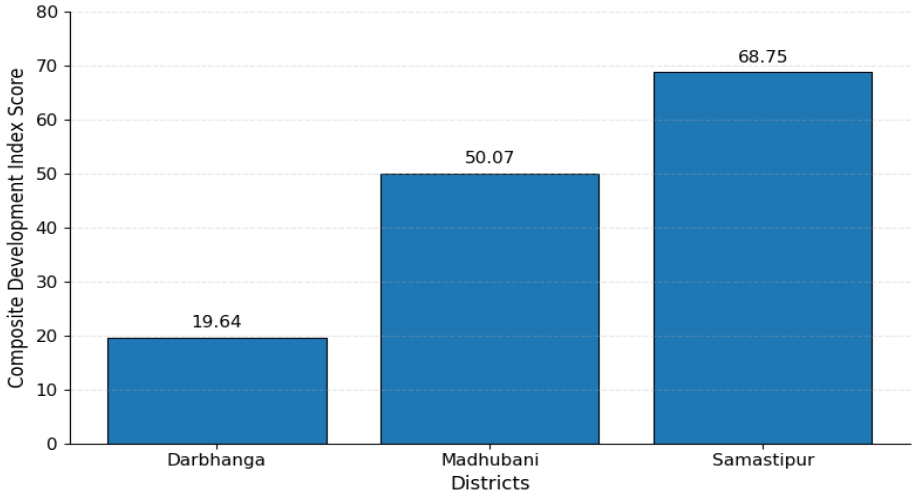

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Figure 1: Bar chart showing the composite development index of Darbhanga, Madhubani and Samastipur.

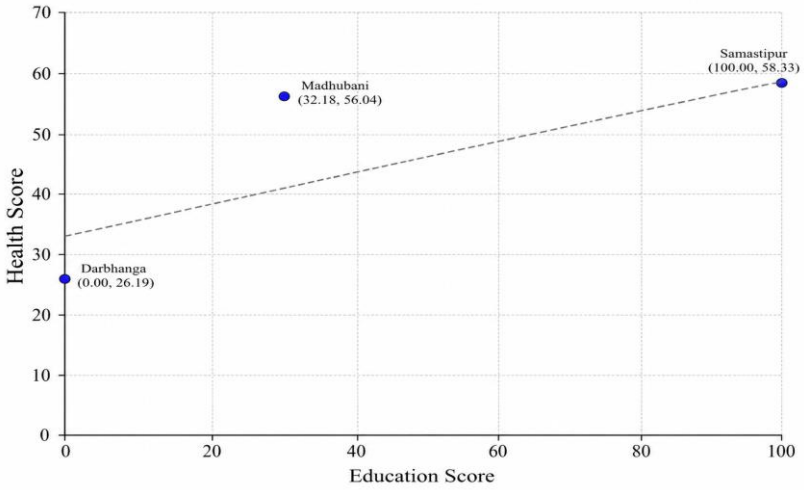

Figure 2: Scatter plot between education score and health score.

VIII. DISCUSSION

The findings indicate that North Bihar's development pattern is uneven even within a geographically and culturally connected region. Samastipur's stronger position in literacy and institutional delivery suggests that public service access and social awareness may be relatively better in this district. However, its poor wasting and underweight indicators show that health service utilization alone cannot solve nutritional deprivation. Nutrition depends on food security, dietary diversity, sanitation, maternal education, income stability and intra-household care practices [14].

Madhubani's position is particularly interesting. It performs better than the other two districts in child stunting, wasting and underweight, but it records the highest child anaemia. This suggests that calorie-related and anthropometric indicators may improve without adequate micronutrient security. Anaemia is linked to iron deficiency, poor dietary diversity, infections, maternal anaemia and inadequate supplementation. Therefore, Madhubani requires a specific strategy for anaemia reduction through iron-folic acid supplementation, dietary diversification, school-based nutrition programmes and adolescent girls' health interventions [15].

Darbhanga's lower composite score reflects persistent gaps in both education and health. Although Darbhanga has important educational and medical institutions, district-level outcomes show that institutional concentration in urban centres does not automatically produce balanced rural development. The district's relatively low female literacy and institutional delivery ratio indicate the need for stronger rural outreach, transport support, women's education and community-level health mobilization. This finding is important because Darbhanga is often perceived as a regional hub, yet its rural development indicators remain constrained.

The study also shows that female literacy is a crucial connecting variable. Higher female literacy can improve health-seeking behaviour, reduce early marriage, increase awareness of antenatal care and support better child-feeding practices. In districts where female literacy remains low, health interventions may face behavioural and informational barriers. Therefore, education policy and health policy should not be treated as separate sectors. Integrated planning is required, especially at block and panchayat levels.

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From a geographical perspective, the three districts face common structural problems: high population density, rural poverty, flood exposure, seasonal migration and dependence on public institutions. Floods and waterlogging can disrupt school attendance, damage sanitation facilities, affect drinking water quality and increase disease risk. Migration can improve household income through remittances, but it may also create care deficits for children and elderly family members. These conditions shape the relationship between education, health and development in the region.

IX. POLICY SUGGESTIONS

The first policy priority is to strengthen female education. Darbhanga and Madhubani require targeted interventions for girls' secondary education, including transport support, scholarship continuity, functional toilets, safe school access and community counselling. Female literacy should be treated as a long-term health investment, not only as an educational target.

The second priority is to improve child nutrition through convergence. Anganwadi services, school meals, health sub-centres, adolescent health programmes and public distribution systems should work in a coordinated manner. Madhubani requires a specific anaemia control strategy, while Samastipur requires focused action on wasting and underweight. Darbhanga needs a broad maternal-child health and nutrition strengthening plan.

The third priority is to improve institutional delivery and postnatal care in weaker blocks. Darbhanga's institutional delivery ratio is lower than that of Madhubani and Samastipur. This gap can be reduced through better ambulance access, birth preparedness counselling, ASHA incentives, monitoring of high-risk pregnancies and strengthening of primary health facilities.

The fourth priority is to create district-level human development dashboards. Indicators such as female literacy, school attendance, institutional delivery, anaemia, stunting, wasting and adolescent nutrition should be tracked at block level. District averages often hide sharp local inequalities. A block-level index would help identify the most deprived pockets.

The fifth priority is to connect health and education programmes with flood-resilience planning. Schools and health centres in flood-prone areas should have contingency arrangements, safe drinking water, emergency transport mapping and seasonal learning-support plans. Development planning in North Bihar must be geographically sensitive.

X. CONCLUSION

The comparative assessment of Darbhanga, Madhubani and Samastipur shows that educational and health indicators are powerful measures of development in North Bihar. Samastipur ranks first in the composite index because of stronger literacy and institutional delivery indicators, but it still faces serious child nutrition challenges. Madhubani occupies the middle position because of better anthropometric child nutrition outcomes, but its high child anaemia and moderate female literacy restrict its overall development status. Darbhanga ranks lowest because of weaker literacy, female literacy and institutional delivery performance.

The study confirms that development in North Bihar is multidimensional. A district may perform well in one indicator but poorly in another. Therefore, development policy must move beyond general district-level claims and focus on specific combinations of educational and health deprivation. Female literacy, maternal health service utilization, child nutrition and anaemia control should be treated as interconnected priorities. The most important conclusion is that human development in North Bihar depends not only on expanding infrastructure but

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also on improving the actual capability of households—especially women and children—to access education, health and nutrition services.

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