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ASSESSING SPATIAL INEQUALITY IN HIGHER EDUCATION: A LOCATION QUOTIENT AND CORRELATION ANALYSIS FROM MIZORAM, INDIA

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ABSTRACT

The uneven distribution of higher education institutions is an important dimension of spatial inequality, particularly in mountainous region like Mizoram where access is shaped by geographic barriers as much as by policy. This study investigates the distribution of undergraduate colleges in Mizoram, India, with a focus on whether institutional presence reflects population patterns across districts. Using spatial mapping and Location Quotient (LQ) analysis, the study measures the relative concentration of colleges, while a correlation test with population density examines whether demographic pressure influences institutional allocation.

The study finds evidence of significant concentration of colleges in the state capital district, while most other districts host only one or two colleges. LQ values suggests allocation of colleges is disproportionate to population, indicating over-representation in the state's capital district and under-representation in the peripheral districts. The study also finds positive association between population density and LQ, suggesting that denser districts tend to be over-represented while peripheral districts are under-represented, making the distribution unequal.

The study calls for a spatially sensitive approach to balancing the distribution of higher education institutions across the state. Aligning institutional placement with demographic demand that would reduce geographic barriers to access and ease the economic and social burdens faced by residents of peripheral districts. In doing so, the research provides empirical evidence for spatial inequality in higher education and highlights the need for policy attention in Mizoram.

KEYWORDS: *Spatial inequality, GIS, Higher Education, College Access, Location Quotient, Mizoram, India*

1. INTRODUCTION

Mizoram, a border state in Northeast India with an estimated population of 1.745 million in 2023, consistently ranks among the highest in the country for literacy, at around 91 percent. This achievement provides a strong base for participation in higher education, which is widely recognised as a key driver of social mobility and balanced regional development. Yet the benefits of high literacy do not automatically carry forward unless opportunities for higher study are equitably available. In geographically challenging regions such as Mizoram, where remoteness and difficult terrain shape everyday life, the spatial distribution of colleges plays a decisive role in determining who can realistically access higher education.

Unequal access to higher education can disadvantage otherwise capable students, increase household costs for those required to migrate or commute, and widen disparities between districts. While Mizoram has achieved strong outcomes in early education, the benefits of high literacy cannot be fully realised unless opportunities in higher education are geographically accessible. Many developed countries have sought to bridge this gap by distributing institutions more evenly across regions, recognising that progression from basic to higher education depends not only on student readiness but also on the spatial availability of colleges. Identifying and measuring these barriers in Mizoram is therefore essential to understanding whether spatial inequality in higher education exists, and to assess how the state's educational gains at the school level can be translated into equitable opportunities for higher studies.

This study examines the extent of spatial inequalities in Mizoram's higher education system by analysing the distribution of 36 undergraduate colleges across its 11 districts. It seeks to determine whether access to higher education is equitably distributed or concentrated in certain areas, potentially marginalising students in peripheral districts. The analysis maps the spatial patterns of college locations, quantifies disparities in their distribution relative to district populations, and investigates how closely these patterns align with demographic characteristics.

2. LITERATURE REVIEW

The spatial distribution of higher education institutions in India has long been recognized as uneven, with implications for equity and access. Tilak (2015) notes that Indian higher education is characterised by regional imbalances, with institutional concentration in urban centres and weaker provision in peripheral regions. These disparities persist despite India's relatively high overall expansion of higher education, and they disproportionately affect smaller states in the Northeast, such as Mizoram.

In alignment with the National Education Policy (NEP) 2020, which emphasizes equitable access to higher education across geographic and social groups, spatial analysis becomes an important lens through which to examine gaps in institutional

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provision. Several GIS-based studies within India provide methodological and empirical precedents. Kumar and Singh (2019), in their spatial analysis of college distribution in Uttar Pradesh, employed GIS mapping to reveal strong clustering of institutions in urban districts, leaving rural regions underserved.

Internationally, GIS and LQ studies support the use of LQ-density correlations to identify spatial inequalities. Chen et al. (2021), in their study of basic education in Shanghai, found that LQ values strongly correlated with local population density, yet found under-representation in less dense areas, indicating unequal access. Similarly, Wang et al. (2022) examined rural areas around Wuhan and demonstrated that institutional concentration followed settlement density. Beyond China, Singleton et al. (2012) applied spatial interaction modelling and geodemographic analysis in the UK to assess higher education participation, revealing that distance and institutional clustering significantly influence student access, particularly disadvantaging peripheral and rural regions. The study collectively demonstrate that a positive LQ-density correlation indicates spatial inequality in provision, as educational institutions tend to concentrate in denser areas, leaving less dense regions with disproportionately fewer facilities relative to their population.

3. OBJECTIVES

1. To map and visualize the spatial distribution of 36 higher education institutions across Mizoram's 11 districts using QGIS, identifying patterns of concentration and dispersion.
2. To measure relative disparities in higher education access by calculating Location Quotient (LQ) values, highlighting districts with over- or under-representation of colleges relative to population.
3. To assess the relationship between LQ values and district-level population density through Pearson's correlation, evaluating the extent to which institutional distribution aligns with demographic patterns.
4. To integrate spatial and statistical findings into a district-level comparative framework, providing empirical evidence of higher education inequality in Mizoram.

4. METHODOLOGY

This study employs a descriptive, GIS-based approach to examine the spatial distribution of higher education institutions across Mizoram's 11 districts. It integrates geospatial digitization with statistical analysis to map college locations, compute Location Quotient (LQ) for quantifying disparities in access relative to population, and perform Pearson's correlation to assess associations with population density.

4.1 Study Area

Mizoram, a northeastern Indian state, covers an area of approximately 21,087 km^2 and has an estimated population of 1.745 million in 2023, projected from the 2011 Census using a decadal growth rate of 23.48% (Office of the Registrar General & Census Commissioner, India, 2011). The state consists of 11 districts with varying demographic and geographic characteristics. The district population figures range from 45,276 in Hnahthial to 580,172 in Aizawl, while district areas differ from 1,100.80 km^2 in Hnahthial to 3,417.20 km^2 in Lunglei. Population density, calculated as population per km^2, ranged from 41.13 in Hnahthial to 249.61 in Aizawl.

4.2 Data Source and Handling

The study covers 36 higher education institutions in Mizoram that offer full-time undergraduate degree programs (three to five years) in disciplines such as Arts, Commerce, Science, Engineering, Medicine (MBBS), Paramedical Sciences and Nursing, taking 2023 as the base year. The institutional sample included colleges affiliated with Mizoram University (MZU), along with centrally funded entities such as the National Institute of Technology Mizoram (NIT Mizoram), the National Institute of Electronics and Information Technology (NIELIT), the Regional Institute of Paramedical and Nursing Sciences (RIPANS), and the College of Veterinary Sciences and Animal Husbandry, Selesih (under the Central Agricultural University, Imphal). Institutions that exclusively offered diploma, postgraduate, or research programs were excluded from the analysis. Of the 36 institutions, four are under the Government of India, two under the University Grants Commission (Mizoram University and its constituent Pachhunga University College), three are privately managed, and the remainder are state government institutions. Secondary data were compiled primarily from the list of affiliated colleges published on the Mizoram University website, reports from the Directorate of Higher and Technical Education, Government of Mizoram, and official websites of the non-affiliated institutions.

4.3 Data Analysis Techniques

Geographic data of the institutions studied were assembled into a shapefile featuring 36 point-geometries, each with attributes for institution name, Type of the Institution (e.g., Arts, Arts and Commerce, Engineering, Medical), management type (State Government, University Grants Commission, Government of India, Central Agricultural University, or Private), and districts in which each institution are located.

A complementary shapefile was also prepared, containing 11 polygon geometries with attributes for 2023 population estimates and district area in EPSG:32646 (UTM Zone 46N) for coordinate system consistency. The Mizoram district boundary shapefile was validated against the official state area of 21,081 km², with a minor difference of 0.09% (18.8 km^2) with no invalid geometries.
Secondary data, including the baseline population, originated from the 2011 Census and were adjusted for 2023 projections.

To assess relative access, the Location Quotient (LQ) was calculated following Isard (1960):

$$LQ = \frac{(\frac{E_i}{E_t})}{(\frac{P_i}{P_t})}$$

Where E_i is the number of institutions in district i, E_t is the total number of institutions, P_i is the population of district i, P_t is the total population. An $LQ > 1$ indicates a relative concentration of institutions, while $LQ < 1$ reflects under-representation.

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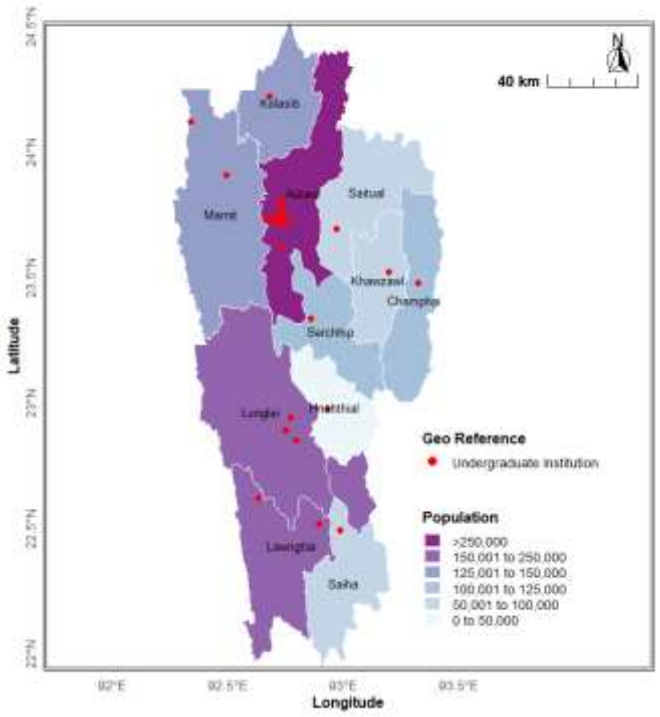
District-level population density was also computed and Pearson's correlation test was performed between district-level LQ values and population density. Digitization was performed in QGIS, version 3.40 and statistical analysis was conducted in R version 4.5.0. Choropleth map and table are produced to visualize spatial patterns of concentration and disparity across districts.

5. RESULTS

Figure 1 presents a Geographic Information System (GIS) map showing the distribution of 36 undergraduate colleges across Mizoram in relation to the 2023 population estimates. College locations are plotted as red points, while district polygons are shaded using a sequential blue-purple gradient to indicate population size. District names are labelled, and the map includes a graticule with longitude (beginning at 92.0°E) and latitude coordinates for spatial reference.

The map demonstrates a marked concentration of higher education institutions in the Aizawl district, which contains 21 colleges (58.3% of the total) despite a population of 580,172 (249.61 persons/km²). In comparison, peripheral districts such as Champhai (113,253; 73.95 persons/km²), Saiha (89,987; 60.08 persons/km²), and Serchhip (103,277; 76.48 persons/km²) each host a single college. Hnahthial, with a population of 45,276 (41.13 persons/km²), also has only one institution. These contrasts highlight the spatial unevenness in provision, with higher education opportunities concentrated in the state capital and limited availability in districts with smaller populations and lower population densities.

Figure 1: Spatial Distribution of Undergraduate Institutions in Mizoram 2023



Source: Own visualisation based secondary data and Population estimate for 2023

Table 1: District-Level Distribution of Higher Education Institutions

	District	Area in Km^2	Population	Pop. density km^2	College Count	Percent of colleges	LQ
1	Aizawl	2,324.30	580,172	249.61	21	58.33	1.75
2	Champhai	1,531.50	113,253	73.95	1	2.78	0.43
3	Hnahthial	1,100.80	45,276	41.13	1	2.78	1.07
4	Khawzawl	1,133.60	57,140	50.41	1	2.78	0.85
5	Kolasib	1,346.10	133,548	99.21	1	2.78	0.36
6	Lawngtlai	2,484.00	187,504	75.48	2	5.56	0.52
7	Lunglei	3,417.20	211,463	61.88	4	11.11	0.92
8	Mamit	3,099.00	137,355	44.32	2	5.56	0.71
9	Saiha	1,497.70	89,987	60.08	1	2.78	0.54
10	Saitual	1,815.40	86,078	47.41	1	2.78	0.56
11	Serchhip	1,350.30	103,277	76.48	1	2.78	0.47

Sources: Own calculation based on secondary data

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5.2 Relative District Representation Using Location Quotient

Table 1 indicates the district-wise distribution of colleges in Mizoram relative to population through the Location Quotient (LQ). The results indicate a high concentration of institutions in Aizawl, which accommodates 21 of the state's 36 colleges (58.33 per cent) and records an LQ of 1.75, indicating an over-representation. By contrast, most other districts show under-representation in institutional presence.

Table 2. Detailed Summary Statistics

Variable	Mean	SD	Min	P25	Median	P75	Max
Pop (2023)	158,641.20	148,543.80	45,276	88,032.50	113,253	162,429.50	580,172
District Area km^2	1,918.17	799.8	1,100.80	1,348.20	1,531.50	2,404.15	3,417.20
Pop Density km^2	80	58.87	41.13	48.91	61.88	75.98	249.61
Colleges	3.27	5.95	1	1	1	2	21
LQ	0.74	0.4	0.36	0.49	0.56	0.88	1.75

Source: Own calculation from secondary data

Kolasib (0.36), Champhai (0.43), Serchhip (0.47), and Saiha (0.54) register the lowest LQ values, each with only a single college despite their populations exceeding 80,000. Districts such as Mamit (0.71), Saitual (0.56), Lawngtlai (0.52), and Khawzawl (0.85), although slightly higher, exhibit level below parity. Lunglei, with four colleges (11.11 per cent), approaches proportional representation but remains below unity (0.92). The only district near balance is Hnahthial, with an LQ of 1.07, a new district (2019) with a single college serving a relatively small population.

5.3 Distributional Characteristics of LQ and Population Variables

Table 2 presents descriptive statistics for Mizoram's 11 districts, highlighting variations in population, district area, population density, college counts, and Location Quotient (LQ). The population across districts indicates significant demographic disparities, ranging from 45,276 to 580,172, with a mean of 158,641 and a standard deviation of 148,544. District areas vary from 1,100.80 km² to 3,417.20 km² (mean 1,918.17, SD 799.80), while population density spans 41.13 to 249.61 per km² (mean 80.00, SD 58.87). The number of colleges ranges from 1 to 21, with a mean of 3.27 and a high standard deviation of 5.95, reflecting uneven institutional distribution. The LQ, measuring college concentration relative to population share, ranges from 0.36 to 1.75, with a mean of 0.74 and a standard deviation of 0.40. The result suggests significant inequality in the provision of higher education facilities across districts.

5.4 Link Between Institutional Concentration and Population Density

The Pearson's correlation analysis (Table 3) indicates a statistically significant positive relationship between LQ and population density ($r = 0.678$, $p = 0.022$). This implies that districts with higher population density not only host more colleges in absolute terms, but are also relatively over-represented compared to their population share. Conversely, sparsely peripheral districts which are sparely populated compared to Aizawl District are systematically under-represented, reflecting a concentration of higher education opportunities in the state's capital rather than a proportional distribution across the state.

Table 3. Summary of Pearson's Correlation

Statistic	Value
Correlation Coefficient	0.678
T-statistic	2.765
Degrees of Freedom	9
P-value	0.022
95% CI Lower	0.131
95% CI Upper	0.908

Source: Own calculation

Taken together, the spatial mapping, LQ analysis, and correlation result provides district-level empirical evidence to understand spatial barriers in access to higher education. The evidence indicate that Aizawl dominates in both absolute and relative concentration, peripheral districts lag behind considerably, and population density only partially explains disparities. This integrated approach highlights the multi-dimensional nature of educational inequality in Mizoram, offering an empirical baseline for assessing spatial equity in access to higher education.

6. KEY FINDINGS

The spatial distribution of Mizoram's 36 undergraduate institutions highlights a pattern of highly uneven geographic concentration. As shown in the results, Aizawl district hosts

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over half of all colleges in the state, while several districts, such as Champhai, Kolasib, Khawzawl, Saiha, Saitual, and Serchhip, have only a single college each. This imbalance indicates that opportunities for higher education are heavily concentrated in a single district, whereas many districts despite having significant populations, remain underserved.

The Location Quotient (LQ) analysis revealed sharp disparities in relative access. Aizawl's LQ of 1.75 confirms that it is over-represented in institutional presence compared to its share of population. At the other extreme, Kolasib (0.36), Champhai (0.43), and Serchhip (0.47) are under-represented. Only Hnahthial approaches parity with an LQ near 1. The distribution indicates that inequality is not random, with a few districts capturing a disproportionate share of institutional capacity, while the majority of districts fall short of equitable provision.

The Pearson's correlation analysis reveals a significant positive association between Location Quotient (LQ) and population density ($r = 0.678$, $p = 0.022$), indicating that districts with higher population density, such as Aizawl, tend to have higher LQ values and thus possess a greater concentration of colleges. However, this does not suggest an equitable distribution. The LQ values, ranging from 0.36 (Kolasib) to 1.75 (Aizawl), with a mean of 0.74, median of 0.56, and standard deviation of 0.40, demonstrate significant variation. Seven of the 11 districts have LQ values below 0.6, indicating under-representation of colleges relative to their population share, while Aizawl district is over-represented. This skewed distribution, coupled with the positive correlation, suggests that colleges are disproportionately concentrated in denser districts, leaving less densely populated peripheral districts consistently underserved and potentially affecting students in lower-density regions who face greater barriers to accessing higher education.

7. POLICY IMPLICATIONS

The concentration of higher education institutions in Aizawl suggests that addressing spatial inequality will require targeted interventions. Several policy options are available. One approach is the establishment of satellite campuses or constituent colleges in peripheral districts, which can extend the reach of existing institutions without requiring full-scale new institutions. Another is to promote private or community institutions in underserved areas, supported by state subsidies or public–private partnerships.

Infrastructure investment also has an important role. Improved hostel and transport facilities could reduce the cost burden for students from distant districts, while better digital connectivity would allow blended and distance-learning models to complement physical provision. Targeted scholarships for students from under-represented districts could further mitigate geographic disadvantages.

Such measures would not only reduce barriers to access but also distribute opportunities more evenly across the state. In the longer term, ensuring that institutional growth reflects demographic and geographic realities would help align Mizoram with the national goals of equitable access, while also fostering more balanced regional development.

8. CONCLUSION

By combining spatial visualization, Location Quotient analysis, and correlation testing, the study demonstrates that access to higher education is uneven and structurally concentrated in Mizoram. The findings suggest that the concentration of undergraduate institutions within the state capital risks sidelining students with significant academic potential who are unable to overcome geographic distance and financial barriers, thereby constraining both individual aspirations and the broader development of human capital in the state. Ultimately, reducing spatial inequality in higher education is not only a matter of fairness in access, but a prerequisite for balanced regional growth and long-term economic development of the state.

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