IJISEM
INTERNATIONAL JOURNAL OF INNOVATIONS IN SCIENCE ENGINEERING AND MANAGEMENT

International Journal of Innovations In Science Engineering And Management

Check for updates

OPEN ACCESS

Volume: 5

Issue: 4

Month: November

Year: 2026

ISSN: 2583-7117

Published: 05.11.2026

Citation:

Vimal Kumar Jaiswal, Amrita Singh "A Comparative Urban–Rural Analysis of Fertility and Female Literacy across Indian States" International Journal of Innovations In Science Engineering And Management, vol.5, no.4, 2026.

DOI:

10.69968/ijisem.2026v5i4261-265

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A Comparative Urban–Rural Analysis of Fertility and Female Literacy across Indian States

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Abstract

The process of fertility transition in India has been quite heterogeneous among its states. Female education has long been considered one of the most stable predictors of such a trend. In this study, the total fertility rate (TFR) and female literacy rates are compared in terms of 20 Indian states, providing urban and rural estimates separately for each state. Descriptive statistics, Pearson's correlation coefficient, and independent samples t-test were applied to describe the relationship and test the differences between sectors. In the sample, the mean TFR was 1.80 children per woman (SD = 0.31), while the mean female literacy rate was 74.39 per cent (SD = 10.95). The correlation between these variables was statistically significant ($r = -0.678$, $p < 0.01$) and quite high (explained variance is 46 per cent). The mean TFR was significantly lower in urban areas than in rural areas. At the same time, urban areas have a significantly higher literacy rate (82.70 against 66.08 per cent; mean difference is 16.62 per cent, $t(38) = 7.39$, $p < 0.001$). Intra-sectoral variation is high as well: while rural Bihar exhibits a TFR of 2.8 with female literacy at 58.7% and rural Kerala shows literacy of 94.1% together with a TFR of 1.9%. These findings lend credence to the notion that increasing the levels of female literacy, especially in the rural regions of states with higher fertility, would be conducive to completing the demographic transition of India. Given the correlational nature of the study, the findings indicate association rather than causation.

Keywords: *Fertility; Female Literacy; Total Fertility Rate; Urban-Rural Variation; Indian States; Demographic Transition.*

INTRODUCTION

India's fertility has declined remarkably within a relatively short period. Several rounds of the National Family Health Survey and Sample Registration System have indicated that the country's total fertility rate has been steadily declining and that it has reached around the replacement level of 2.1 children per woman, or even slightly below it in some estimates. The national average is not an accurate picture of any state in particular. Kerala and Tamil Nadu have reached the replacement level. Long back, Bihar, Uttar Pradesh, and neighbouring states continued to have fertility rates higher than replacement, especially in their rural areas. The literature on the subject, on the other hand, often uses averages for states or districts in their analysis. Such aggregation masks the disparity between rural and urban areas in the same states. Urban areas provide better education for women, employment opportunities, better access to health facilities, and increased costs of child-rearing. Rural areas tend to have low literacy rates, early marriage, and poor access to facilities. Even in an area characterised by a relatively higher average literacy rate, there can be some sections within the same state whose demographic behaviours might be similar to those in areas with lower literacy rates. Considering the population of each state separately according to whether it is urban or rural, one can observe these variations simultaneously within a single picture. This study will make use of 40 state-sector observations.

LITERATURE REVIEW

Dyson and Moore (1983) found that the variation in family systems and female autonomy in the region could help explain differences in demographic results. Indeed, the differences between the northern and southern family systems played an important sociological role in explaining variations in women's reproductive behaviours. [1]

Murthi, Guio and Dreze (1995) offer evidence from the district level showing the relationship between female literacy, fertility, mortality, and gender bias in India. The authors found that female literacy was among the important socioeconomic correlates related to the outcomes of fertility. [2]

Drèze & Murthi (2001) conducted a study of fertility differentials and trends in Indian districts using information from 1981 and 1991. In the study, it was noted that women's education and childhood mortality emerged as some of the most critical factors contributing to fertility differentials and trends. [3]

Basu (2002) explored the various possible mechanisms by which female education might impact reproductive behaviour. This theoretical framework enables an explanation of why the impact of education can vary between different social groups despite the same level of literacy in both populations. [4]

McNay, Arokiasamy, and Cassen (2003) demonstrated that the link between education and fertility continued to hold. Diffusion processes, such as the behaviour of other women regarding their use of contraceptives, education, and mass media, were some of the factors noted to affect fertility rates.[5]

Reddy (2003) examined the replacement fertility of women with high school education or higher and found that the use of family planning was highly correlated with female education. The importance of this study for our current research is that it proves the multidimensional nature of the education-fertility link. [6]

Mohanty, Fink, Chauhan, and Canning (2016) analysed that fertility has declined in 640 districts of India. This analysis employed district-level data and difference-in-difference models to analyse the influence of factors such as female literacy rate, under-five mortality, and poverty. [7]

Pallikadavath, Rajan & Wilson (2016) researched low fertility and sterilisation among women in South India. They used a pseudo-cohort based on NFHS data, as well as qualitative analysis in Kerala and Tamil Nadu. This research is significant because it proves the possibility of a reciprocal relationship between fertility and women's educational achievements. [8]

Chatterjee's (2020) district-based analysis of West Bengal. Through the use of data from the Census 2011 and NFHS-4 survey. Chatterjee was able to show the presence of persisting urban-rural disparities in fertility, even though this difference had started to close. [9]

Jha and Banerjee (2025) investigated women's educational levels and information dissemination processes. The findings from this research suggest an independent negative relationship between education and fertility, with mass media usage, social networks, family structure, economic independence, and gender roles also being involved in reproductive decisions. [10]

Bhattacharjee (2026) offers evidence from a recent quasi-experimental approach through the investigation of the schooling policy implemented in India in 2010. It is reported that additional schooling results in delayed marriage, postponed sexual debut, higher usage of contraception, and lower fertility. [11]

Research Gap

Although previous studies have documented a strong connection between female education and fertility in India, there exist significant lacunae regarding the nature of the relationship in an analysis conducted simultaneously at the state and state-sector levels. Previous research has mostly centred on determinants at the individual, district, or state level, but not on a unified state-sector approach based on indicators of female literacy and total fertility rate. Modern studies have stressed the process of women's empowerment, contraception, early marriage, communication, and socioeconomic status, whereas there is less stress on conducting a comparative study of the direct relationship between literacy and fertility at the state-sector level. This study attempts to fill the research void by considering 20 states in India and using descriptive analysis.

Research Hypothesis

H_1: There is a significant negative relationship between female literacy and total fertility rate (TFR) across the selected Indian states.

H_0: There is no significant relationship between female literacy and Total Fertility Rate across the selected Indian states.

METHODOLOGY

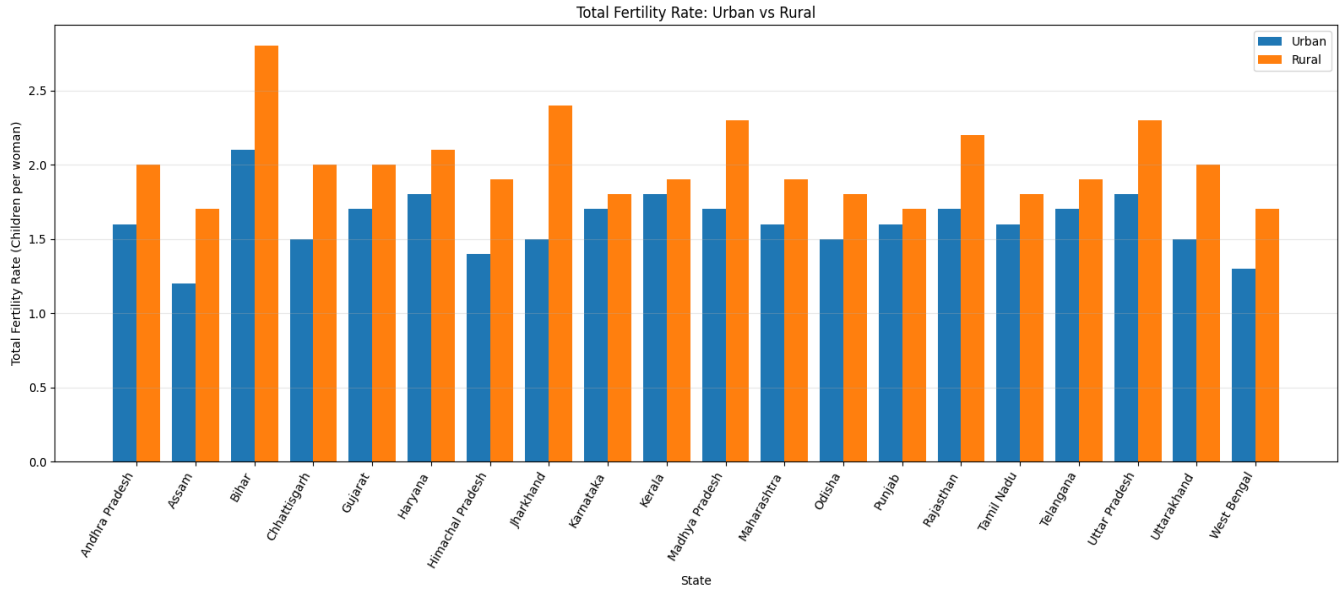
In this study, a quantitative and comparative research design was employed to investigate the relationship between the literacy rate among women and their fertility in certain Indian states, with special attention to the urban-rural distinction. All data used in this study were secondary and sourced from reputable governmental agencies. Data on the

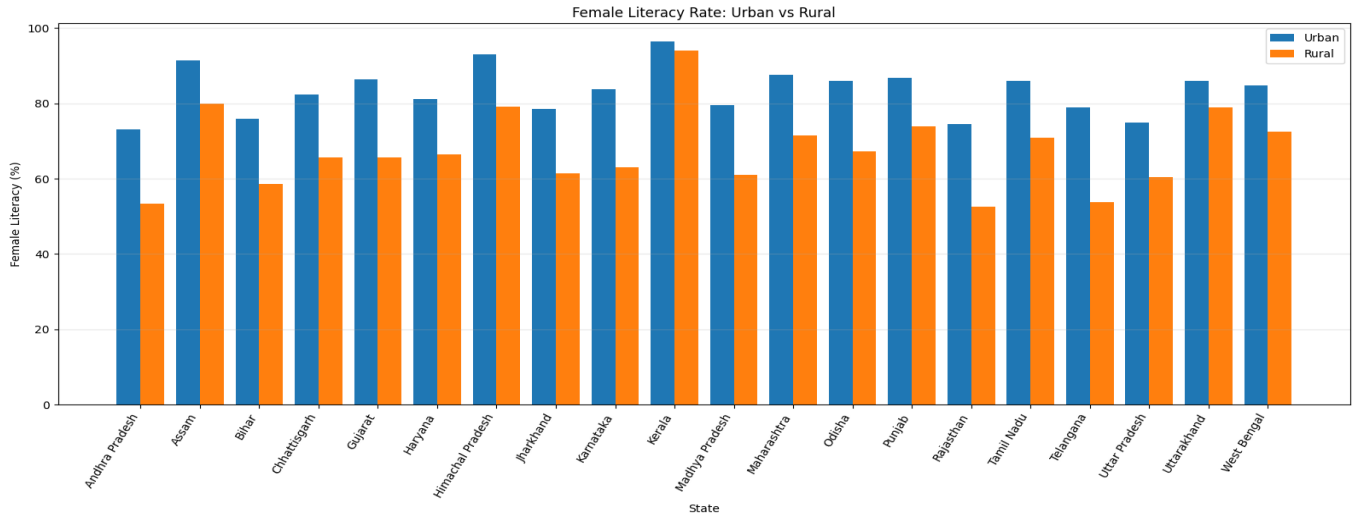
total fertility rate (TFR) and other fertility indicators were sourced from the National Family Health Survey – 5 (NFHS-5). Female literacy data were sourced from the Ministry of Statistics and Programme Implementation (MoSPI), Government of India. This study used a total of 20 Indian states. Observations were taken separately in the urban and rural sectors, thus leading to 40 observations by state and sector. TFR was the main dependent variable, while the female literacy rate (%) was the explanatory variable, with sector (urban/rural) as the group variable. The data collected were organised, verified, and tabulated using Microsoft Excel. IBM SPSS Statistics was then used to conduct statistical analysis. Descriptive statistics, such as the number of observations, minimum, maximum, mean, and standard deviation, were used in the summary of the distribution of TFR and female literacy. Pearson's product moment correlation coefficient was used to test the relationship in terms of direction and strength between female literacy and TFR, while an independent samples t-test was used to find out if there were any statistically significant differences between the urban and rural areas in terms of fertility and female literacy. The analysis was conducted using a 5% level of significance ($\alpha = 0.05$) and a 95% confidence interval. There were 40 valid observations in the SPSS database for this analysis. The study appreciates the fact that the statistical analysis is carried out using aggregate secondary data and a cross-sectional design. The statistical association can only indicate association and not causation. Income, age at marriage, contraception use, employment status, health care services, infant mortality, and other factors can also affect fertility and are not controlled for here. Therefore, the methodology is intended to provide a systematic comparative assessment of the relationship between female literacy and fertility and the differences between urban and rural areas across the selected Indian states.

Data Analysis and Interpretation

State-wise Total Fertility Rate and Female Literacy Rate in Urban and Rural Areas

	Total Fertility Rate (Children per woman)	Total Fertility Rate (Children per woman)	Female Literacy (in %)	Female Literacy (in %)
State	Urban	Rural	Urban	Rural
Andhra Pradesh	1.6	2	73.1	53.4
Assam	1.2	1.7	91.4	79.9
Bihar	2.1	2.8	75.9	58.7
Chhatisgarh	1.5	2	82.3	65.6
Gujarat	1.7	2	86.3	65.6
Haryana	1.8	2.1	81.2	66.4
Himachal Pradesh	1.4	1.9	93	79.2
Jharkhand	1.5	2.4	78.6	61.4
Karnataka	1.7	1.8	83.7	63.1
Kerala	1.8	1.9	96.4	94.1
Madhya Pradesh	1.7	2.3	79.5	61
Maharashtra	1.6	1.9	87.6	71.4
Odisha	1.5	1.8	85.9	67.3
Punjab	1.6	1.7	86.7	74
Rajasthan	1.7	2.2	74.6	52.6
Tamilnadu	1.6	1.8	85.9	70.8
Telangana	1.7	1.9	79	53.7
Uttar Pradesh	1.8	2.3	74.9	60.4
Uttarakhand	1.5	2	85.9	79
West Bengal	1.3	1.7	84.7	72.6





Correlations	Correlations	Correlations	Correlations
		Total Fertility Rate	Female Literacy %
Total Fertility Rate	Pearson Correlation	1	-.678**
Total Fertility Rate	Sig. (2-tailed)		.000
Total Fertility Rate	N	40	40
Female Literacy %	Pearson Correlation	-.678**	1
Female Literacy %	Sig. (2-tailed)	.000	
Female Literacy %	N	40	40

Correlation is significant at the 0.01 level (2-tailed).

Test

Group Statistics	Group Statistics	Group Statistics	Group Statistics	Group Statistics	Group Statistics
	Sector	N	Mean	Std. Deviation	Std. Error Mean
Total Fertility Rate	urban	20	1.6150	.19808	.04429
Total Fertility Rate	Rural	20	1.9850	.29961	.06699
Female Literacy %	urban	20	82.6950	5.52254	1.23488
Female Literacy %	Rural	20	66.0800	8.39590	1.87738

Independent Samples Test	Independent Samples Test	Independent Samples Test	Independent Samples Test	Independent Samples Test	Independent Samples Test
		Levene's Test for Equality of Variances	Levene's Test for Equality of Variances	t-test for Equality of Means	t-test for Equality of Means
		F	Sig.	t	df
		F	Sig.	t	df
Total Fertility Rate	Equal variances assumed	2.203	.146	-4.607	38
Total Fertility Rate	Equal variances not assumed			-4.607	32.946
Female Literacy %	Equal variances assumed	3.294	.077	7.394	38
Female Literacy %	Equal variances not assumed			7.394	32.849

Independent Samples Test	Independent Samples Test	Independent Samples Test	Independent Samples Test	Independent Samples Test
		t-test for Equality of Means	t-test for Equality of Means	t-test for Equality of Means
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
Total Fertility Rate	Equal variances assumed	.000	-.37000	.08031
Total Fertility Rate	Equal variances not assumed	.000	-.37000	.08031
Female Literacy %	Equal variances assumed	.000	16.61500	2.24710
Female Literacy %	Equal variances not assumed	.000	16.61500	2.24710

Independent Samples Test	Independent Samples Test	Independent Samples Test	Independent Samples Test
		t-test for Equality of Means	t-test for Equality of Means
		95% Confidence Interval of the Difference	95% Confidence Interval of the Difference
		Lower	Upper
Total Fertility Rate	Equal variances assumed	-.53258	-.20742
Total Fertility Rate	Equal variances not assumed	-.53341	-.20659
Female Literacy %	Equal variances assumed	12.06598	21.16402
Female Literacy %	Equal variances not assumed	12.04243	21.18757

The collected data have been analysed using two software applications. Microsoft Excel and IBM SPSS Statistics. Microsoft Excel was used to compile, organise, perform basic checks, and present tabular and graphical representations of the data. SPSS was utilised for inferential and descriptive statistics. The descriptive analysis of the 40 observations indicates that the mean total fertility rate was 1.80 children per woman (with a minimum of 1.20 and a maximum of 2.80) and the mean level of female literacy was 74.39% (with a minimum of 52.60% and a maximum of 93.00%). The results obtained from Pearson 'scorrelation analysis show a strong negative correlation between female literacy and TFR ($r = -0.678$, $p < .001$, $N = 40$), which means that high levels of female literacy resulted in low fertility rates in the state sector. In addition, the independent samples t-test showed that the mean TFR was 1.615 in urban areas and 1.985 in rural areas, while the mean female literacy rate was 82.695% in urban areas and 66.080% in rural areas. This shows that there are statistically significant differences between the urban and rural populations with respect to fertility and literacy levels of females in the sample used. Generally, it is evident that there exists an inverse relationship between female literacy and fertility, and also sectoral differences.

RESULTS

The study investigates the correlation between female literacy and Total Fertility Rate (TFR) in 20 Indian states, with urban and rural observations in each state. Thereby making a total of 40 state-sector observations. According to the descriptive analysis results, the average value of TFR in the sample under consideration was 1.80 per woman, with its values varying from 1.20 to 2.80, and the average value of female literacy in the sample was 74.39%, with its values varying from 52.60% to 93.00%. Pearson's correlation analysis was used to examine the correlation between female literacy and TFR. According to the results of Pearson's correlation analysis, there exists a statistically significant ($p < .001$, $N = 40$) and negative correlation ($r = -0.678$) between the two variables. This means that the higher the female literacy, the lower the TFR among the state-sector observations. The correlation value suggests a high negative correlation between the two variables. The squared correlation value is about 0.46, which indicates that 46% of the variance in TFR can be statistically attributed to the variance in female literacy. However, this does not necessarily mean that female literacy is responsible for 46% of the total variation in fertility independently of other demographic, socioeconomic, and institutional variables, as they are not included in the regression model.

CONCLUSION

The study shows that there is a strong inverse correlation between female literacy and fertility in the chosen Indian states. Pearson's correlation analysis revealed an inverse correlation coefficient of $r = -0.678$, implying that high

female literacy occurs together with low fertility. The research reveals the existence of urban/rural differences, such that there are high female literacy rates coupled with low TFR among the urban communities compared to the rural. The mean female literacy was 82.70% in the urban areas against 66.08% in the rural areas. The mean TFR was 1.62 in the urban areas against 1.99 in the rural.

The results are in line with the demographic theory on the relationship between increased women's education and changing reproductive behaviour. Nonetheless, caution should be exercised before interpreting the above results. It is especially significant for understanding the urban-rural comparison because this finding clearly shows that the process of demographic transition in India is not uniform in different geographic locations. The combination of higher literacy and lower fertility rates found in the urban population is complemented by significantly lower literacy and higher fertility in rural populations. This indicates that female education and reproductive issues should be addressed by taking into account geographic and sectoral discrepancies rather than only using national average figures.

Suggestions

1. **Enhance female education in rural areas:** More effort needs to be made to educate girls and ensure that females receive adequate education in rural areas, especially in states where female literacy is still low.
2. **Focus on continuous education:** Educational policies should not only focus on making people literate but also work towards keeping girls in school after primary schooling.
3. **Education combined with family planning programs:** Efforts to educate women should be accompanied by the provision of reproductive health, contraception, and family planning information.
4. **Early marriage prevention programs:** Programs focused on preventing early marriage and ensuring that girls stay in school may lead to better reproductive choices among women.
5. **Decrease the urban-rural education gap:** As per the findings of the analysis, a significant gap in terms of female literacy exists between urban and rural areas; hence, efforts must be made in favour of disadvantaged rural areas.
6. **Enhance rural health and family planning:** Improved access to health facilities and family planning services will help in making informed reproductive decisions.

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