

State-Level Health Insurance Coverage, Educational Attainment and Cataract Surgical Rate in India: An Ecological Study of States and Union Territories, 2023-24

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ABSTRACT

Background: Cataract remains a leading cause of avoidable blindness in India. It is possible that differences in coverage by health insurance and levels of education may have an impact on cataract surgery utilisation; but the relationship between these factors and Cataract Surgical Rate (CSR) at the state level has not been studied well enough yet. The objective was to analyze the association of health insurance coverage and educational status of the households with CSR in the States and Union Territories of India.

Methods: The cross-sectional ecological study utilized secondary data of 35 States and Union Territories in India (except for Manipur because of lack of data) in 2023-24. The data on the proportion of households having health insurance, percent of females and males with at least 10 years of schooling were collected from the NFHS-6, while the number of cataract surgeries from NPCBVI Annual Report. The CSR is the number of surgeries carried out per million population. Descriptive statistics and Pearson's correlation were done.

Results: There were wide variations in health insurance cover, education level of females and males, and CSR among the States and UTs. There was no significant relationship between the health insurance cover and CSR ($r = 0.085$, $p = 0.626$). A weak but non-significant positive relationship existed between women's education level and CSR ($r = 0.291$, $p = 0.090$), while the education level of males was significantly weakly positively correlated to CSR ($r = 0.347$, $p = 0.041$).

Conclusion: For the state/UT-level data, there was no significant relationship between household health insurance coverage and CSR; however, there was a weak positive relationship found for male education levels. This implies that CSR maybe influenced by multiple factors apart from household health insurance and educational levels that affect CSR.

Keywords: Cataract Surgical Rate, Health Insurance, Educational Attainment, Ecological study, NFHS-6, NPCBVI, India

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INTRODUCTION

Vision is a vital aspect of health, independence, learning, productivity and quality of life. Vision loss is a major public health concern worldwide, but a significant proportion of visual impairment can be prevented through timely access to eye care services. Cataract is among the main causes of blindness and visual impairment around the world, especially in developing nations, including India, where problems of accessibility, cost, awareness and availability of services continue.[1]

Approaches to eye health around the globe have increasingly focused on promoting integrated and people-oriented eye care in the context of universal health coverage. The World Health Organization and the Lancet Global Health Commission on Global Eye Health have underscored the need for enhanced primary eye care, financial protection, and tackling the underlying determinants of health like education and socio-economic status.[1,2]

Education, in turn, could enhance health literacy that might promote healthcare-seeking behaviour; financial barriers could hinder access to surgery. Health insurance may offer some protection against the loss of income due to illness.[2] Despite substantial expansion of cataract surgical services under the National Programme for Control of Blindness and Visual Impairment (NPCBVI), cataract remains a major cause of avoidable blindness and visual impairment in India.[3,4]

The National Family Health Survey-6 (NFHS-6, 2023-24) provides the updated state-level data on health insurance and education status among women and men that can be considered along with service delivery metrics.[5] An accurate computation of CSR at state level needs reliable population denominators. Standardized population projection is obtained from official statistics, which is essential in such calculation.[6]

It is important to note that the present research work is based on Cataract Surgical Rate (CSR), which is the rate of cataract surgery per million of the population. CSR is an indicator of the number of operations performed in relation to the total population, and it is different from the cataract surgical coverage (CSC) or effective cataract surgical coverage (eCSC).[7]

Additionally, the NFHS-6 health insurance coverage is related to the status of the presence of at least one member of the family under any health insurance scheme. This coverage does not refer to the insurance status of elderly patients with cataract. Although recent Indian studies have explored the regional variations in cataract surgical coverage (CSC) and effective cataract surgical coverage (eCSC) and the barriers to the uptake of the surgery, [7-10] there is insufficient evidence of the simultaneous association of the state-level household health insurance coverage and educational attainment with Cataract Surgical Rate (CSR) using the 2023-24 data. Therefore, the present cross-sectional ecological study was conducted to examine the state/UT-level

relationship between household health insurance coverage, educational attainment of females and males, and Cataract Surgical Rate in India for 2023-24.

MATERIALS AND METHODS

This was an ecological study where the unit of analysis was State/UT in India. The secondary data of the year 2023-24 were used to look at the relationship between health insurance, education and CSR.

The information regarding percentage of households where at least one member of the household was covered under any health insurance/financing program, percentage of women having completed 10 years or more of education, and percentage of men having completed 10 years or more of education were taken from the NFHS-6 State Fact Sheets (2023-24). (indicators: households with any usual member covered by a health scheme/insurance; women and men with 10 or more years of schooling).[5]

The number of cataract surgeries performed in 2023-24 has been sourced from Annual Report 2023-24, National Programme for Control of Blindness and Visual Impairment (NPCBVI), Ministry of Health & Family Welfare, Government of India. The data pertains to surgeries performed under the NPCBVI programme. The surgeries conducted at Regional Institutes of Ophthalmology (termed as "Others – RIOs" in the report) have been excluded from the state/UT level analysis, as these are national-level tertiary institutes and hence, cannot be attributed to any particular State or Union Territory. [11]

The Projected Population Estimate for the Year 2023 (obtained from Report of the Technical Group on Population Projections, 2011–2036) has been used as the denominator for computing the CSR for the year 2023-24. [6]

CSR for individual States/UTs was computed as follows:

$$\text{CSR} = (\text{Number of cataract surgeries in 2023-24} / \text{Estimated population of the State/UT in 2023}) \times 1,000,000$$

The education variable relates to the proportion of women/men who have completed ≥ 10 years of schooling.

Manipur was excluded due to lack of data on health insurance coverage and educational attainment in the NFHS-6 State Fact Sheets. Other State/UT did not have any missing values. "India" total was used for the purpose of description only and was not considered in correlation analysis.

Descriptive statistics were computed for all variables under study. Pearson's Correlation Coefficient (r) was used to determine the correlation between CSR and the three explanatory variables. P-value < 0.05 was considered statistically significant. Due to low sample size ($n = 35$), the analysis done was exploratory in nature. Scatter diagrams and Choropleth maps were also constructed. Statistical Analysis was performed using Jamovi 2.7.37.

This study involved secondary analysis of publicly avail-

able, de-identified data obtained from above mentioned sources. No identifiable individual-level information was accessed by the investigators, and no contact with human participants was undertaken. Therefore, institutional ethical approval was not required for the present secondary analysis.

RESULTS

Totally 35 states and union territories were considered in the analysis while excluding Manipur due to incomplete data. The descriptive statistics of health insurance coverage (%), percentage of women with at least 10 years of schooling, percentage of men with at least 10 years of schooling and Cataract Surgical Rate (CSR) among the States and UTs of India in 2023-24 are shown in Table-1.

Wide geographic differences in Cataract Surgical Rate (CSR) have been noted among the states and UTs of India (Figure 1). The highest CSR has been reported from Goa, Puducherry, Chandigarh, Madhya Pradesh and Tamil Nadu, while the lowest CSR has been reported from Arunachal Pradesh, Lakshadweep, Sikkim, Meghalaya and Nagaland, indicating substantial interstate variation in cataract surgery services.

Scatter plots for CSR against other study variables are shown in Figures 2-4. No visual linear correlation was observed between CSR and health insurance coverage from the scatter plots (Figure 2). In contrast, the visual examination of the scatterplots showed a potential positive correlation between CSR and educational attainment with the latter being stronger among males than females (Figures 3 and 4).

Table 1. Descriptive statistics of study variables across the states and union territories of India, 2023-24 (n = 35)

Variable	Mean	Median	SD	Minimum	Maximum	IQR
Health insurance coverage, %	61.59	61.10	21.61	9.10	96.00	30.05
Women with ≥ 10 years of schooling, %	52.81	51.10	13.86	32.90	87.00	21.35
Men with ≥ 10 years of schooling, %	59.27	59.50	13.68	35.90	89.00	17.45
Population, thousands ^a	38,619.17	25,892	50,221.03	69	236,484	55,233.50
Cataract operations performed, n	247,403.28	125,931	318,982.57	99	1,380,410	347,207.75
CSR, per million population ^b	5,739.63	5,936	3,329.19	821	14,358	4,392.96

Abbreviations: CSR, cataract surgical rate; IQR, interquartile range; SD, standard deviation.

^a Population is expressed in thousands ('000). ^b CSR, number of cataract operations performed per million population.

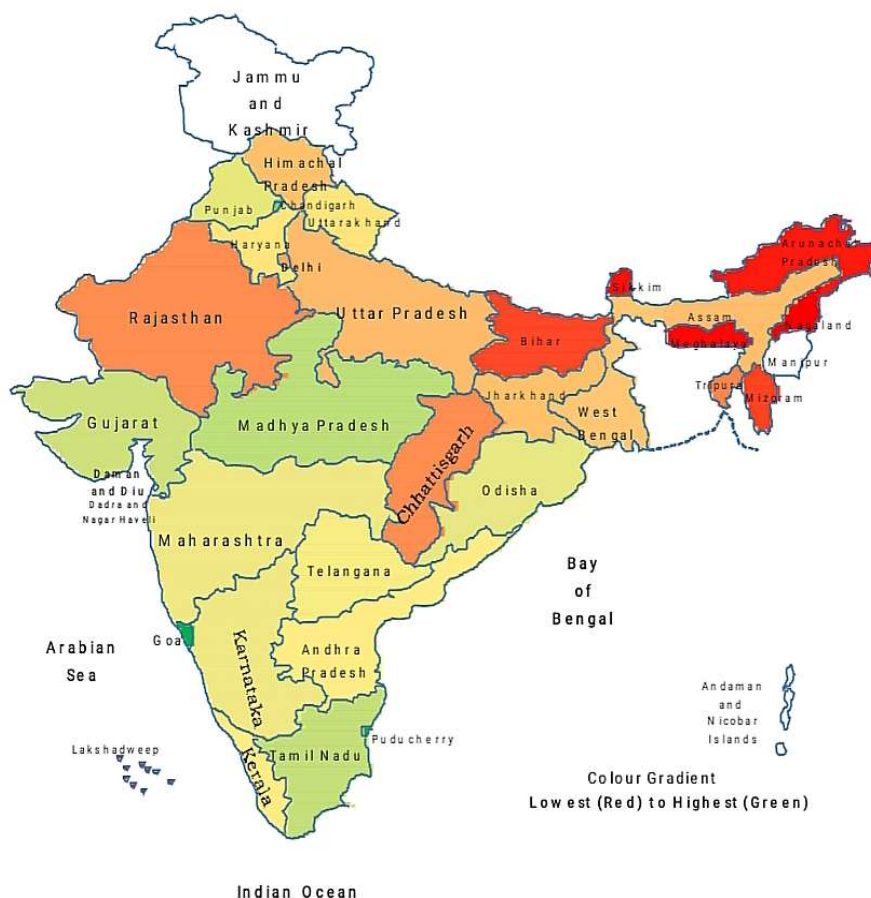


Figure 1 (Choropleth Map): Geographical Distribution of CSR among the States and Union Territories of India for the year 2023-24 (Color gradient from light to dark shows increasing CSR per million people. Approximately: White - Excluded (Manipur - Data Incomplete); <2000; 2000-4000; 4000-6000; 6000-8000; 8000-10000; >10000.

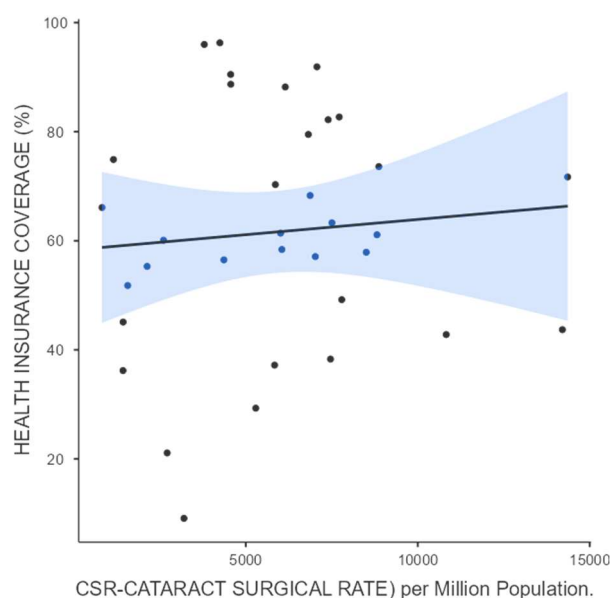


Figure 2: Scatterplot depicting the correlation between state-wise health insurance coverage (%) and Cataract Surgical Rate CSR among the States and Union Territories of India for the year 2023-24. (n=35; Pearson's $r = 0.085$, $p = 0.626$).

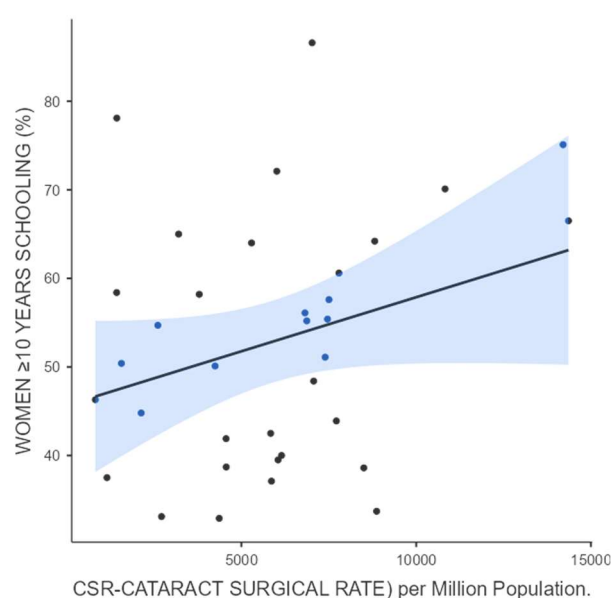


Figure 3: Scatter plot of the association between Women with ≥ 10 years of schooling (%) and Cataract Surgical Rate (CSR) in the States and Union Territories of India, 2023-24. (n=35; Pearson's $r = 0.291$, $p = 0.090$)

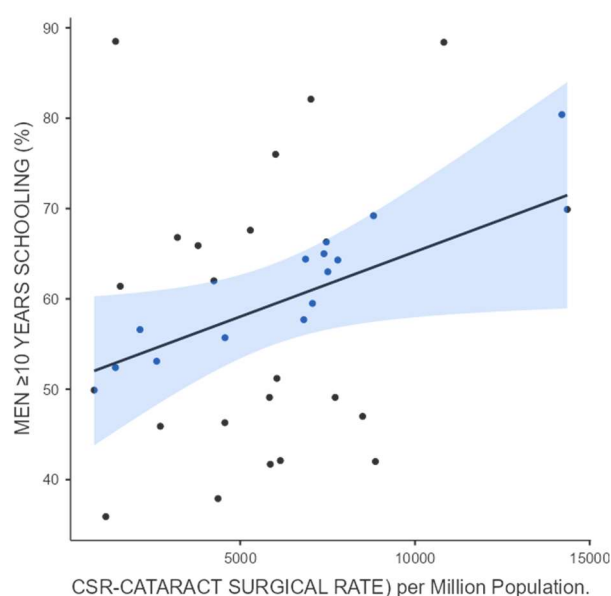


Figure 4: Scatter plot of the association between Men with ≥ 10 years of schooling (%) and Cataract Surgical Rate (CSR) in the States and Union Territories of India, 2023-24. (n=35; Pearson's $r = 0.347$, $p = 0.041$).

Pearson's correlation analysis (Table 2) showed no statistically significant relationship between CSR and health insurance coverage ($r = 0.085$, $p = 0.626$). A weak positive correlation was observed between CSR and the proportion of women with ≥ 10 years of schooling, although this did not reach statistical significance ($r = 0.291$, $p = 0.090$). In contrast, CSR showed a weak but statistically significant positive correlation with the proportion of men with ≥ 10 years of schooling ($r = 0.347$, $p = 0.041$). Given the exploratory analysis and modest association, this finding should be interpreted cautiously.

Spearman's rank correlation was performed as a sensitivity analysis to account for non-normality and outliers. Results were broadly consistent with Pearson estimates (health insurance coverage vs CSR: $\rho = 0.101$, $p = 0.564$; women with ≥ 10 years of schooling vs CSR: $\rho = 0.222$, $p = 0.198$; men with ≥ 10 years of schooling vs CSR: $\rho = 0.298$, $p = 0.082$), although the association with men's schooling was no longer statistically significant.

A sensitivity analysis excluding states with extreme CSR levels showed consistent direction and approximate magnitude of all correlations.

Table 2. Pearson correlation between health insurance coverage, educational attainment and cataract surgical rate in the states and union territories of India, 2023–24 (n = 35)

Variables	Pearson's r	P value
Health insurance coverage (%) vs CSR	0.085	0.626
Women with ≥ 10 years of schooling (%) vs CSR	0.291	0.090
Men with ≥ 10 years of schooling (%) vs CSR	0.347	0.041

Abbreviation: CSR, cataract surgical rate (cataract operations performed per million population).

$P < 0.05$ was considered statistically significant.

DISCUSSION

A cross-sectional ecological analysis conducted on the relationship between the proportion of household health insurance coverage and educational attainment and Cataract Surgical Rate (CSR) among 35 States and UTs of India is described herein. Wide variations were noted for all three measures. There was no statistically significant relationship between household health insurance coverage and CSR. However, women's education did not exhibit any statistically significant relation with CSR, while that of men had a weak positive relationship with CSR.

It is crucial to emphasize once again that CSR is calculated in terms of surgical volume per million population. It is different from cataract surgical coverage (CSC) and effective cataract surgical coverage (eCSC) that measure the share of persons with cataract who had surgery done and the vision status after the procedure. There are many recent articles reporting regional disparities in eCSC in India.[8,9]

In light of this, the lack of an observed association between household health insurance coverage and CSR is quite ambiguous. NFHS-6 indicator shows whether at least one usual resident of the household is insured in any health insurance or financing program. It does not measure the insurance coverage for elderly people with cataract or whether the program covers cataract surgeries. It was previously demonstrated that even in case of partial reimbursement of surgical costs, there are other barriers to surgery like lack of information, delayed health care seeking, transportation problems, need to be accompanied by relatives, additional costs of travelling, accommodation and lost wages.[10,12] General OOP expenditure studies provide evidence about the overall burden of healthcare services utilization in India.[13] There is also cataract-specific literature showing travel burden and costs of surgical care.[14] In light of all these facts, the current ecological study does not mean that health insurance does not work; it means that household health insurance coverage is not enough to explain the difference in surgical volume.

Interpretation of the weak positive correlation between men's level of education and CSR is also needed to be done cautiously. Due to the ecological and cross-sectional nature of this study, the correlation can't be interpreted as the effect of men's education on the incidence of cataract surgeries. It may be due to residual confounding from overall development of the country or from any other confounding variables. Differences between men's and women's levels of education can be attributed to sampling differences or correlation between the two variables.

The National Program for the Control of Blindness and Visual Impairment has made considerable improvements in the provision of cataract surgery in India.[11] Yet the programme's effectiveness is being assessed based not only on numbers of surgeries provided but also on ef-

fectiveness, visual results, and quality of care. Several works conducted within the framework of the Aravind Eye Care System and in the context of rural secondary eye care networks provide additional evidence about the potential of organized, decentralized provision of services as an effective way of increasing numbers and results of procedures.[15,16] Unmet need for cataract surgery has been decreasing, yet still persists among socioeconomically deprived populations according to data from the LASI and other surveys.[17,18] Integrated and community-based eye-care approaches have also been proved to enhance access and referral pathways.[19,20]

Based on a public health viewpoint, the above study results indicate that there are probably many demographic, socioeconomic, and health system factors apart from the proportion insured and education which affect state-level CSR. Improving the provision of primary eye care services, addressing the indirect barriers, improving the referral system, and maintaining quality of surgery are probably some important areas. This is in line with the WHO's and the Lancet Global Health Commission's approach to integrating people-centered eye care. [1,2]

In conclusion, the present study provides recent evidence concerning the ecological association between some of the socioeconomic variables and the CSR rate. The study findings can possibly help in generating hypotheses and planning of the health system concerning equitable cataract surgery services in India, while emphasizing the requirement for further studies on individual level and coverage-based indicators.

STRENGTHS AND LIMITATIONS

This study used secondary data from NFHS-6 (2023–24) and the NPCBVI Annual Report (2023–24) to assess associations of household health insurance coverage and education with CSR across Indian states/UTs. Standardized datasets improved comparability; the ecological design identified geographical differences.

Limitations include ecological fallacy: findings reflect population-level associations and cannot be generalized to individuals. Confounders such as cataract prevalence, age distribution, economic status, access to eye care centres and private-sector contributions could not be adjusted for. CSR depends on surgical volume and other determinants beyond the independent variables. There is also a mismatch in level of measurement: insurance coverage is a broad, household-based measure, whereas CSR is a state-level variable. Other limitations include multiple comparisons, possible outliers or non-linear relationships, and spatial or ecological confounding, all particularly relevant given the small number of analytical units ($n = 35$). Manipur was excluded owing to missing data on one or more study variables.

CONCLUSION

This cross-sectional ecological study identified significant

ant variations in the patterns of household health insurance and educational attainment, and its association with Cataract Surgical Rate (CSR) across the State and Union Territories of India. At the state/UT level, there was no significant association between household health insurance coverage and CSR. There was a weak positive correlation with men's educational attainment, and no significant evidence of an association with women's educational attainment. These findings suggest that CSR may be influenced by various factors beyond those considered in this study. This can provide preliminary evidence for health-system planning and further research to investigate factors associated with equitable cataract surgical services in India.

Individual Author's Contribution: TPT and KTT contributed to the study conception, data collection, and manuscript preparation. KTT contributed to the study conception, study design, data collection, data analysis and interpretation, and manuscript preparation.

Availability of data: The data that support the findings of this study are available from the corresponding author on reasonable request.

Declaration of Non-use of generative AI Tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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