

**Title:**

Indexing Access to Surgical Care in Rural India: Multi-methods Modeling and Construction of a Novel Index

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**Conflicts of Interest:**

None

**Background:**

The Lancet Commission on Global Surgery (LCoGS) estimated that 98% of people in India lack timely access to safe and affordable surgical care. Solving India's surgical access issues can have high returns on investment. While healthcare access and unaffordability problems are well-known in India particularly among its rural people, research and policy focus on surgical care is scant. We fill the research and policy gap by introducing a novel Zadey-Vissoci access to surgical care index (ZVASCI) estimated at state and district-levels for rural regions.

**Methods:**

Secondary analysis of data from 12 different sources with a diverse geospatial and statistical toolbox was used to create state, and district-level estimates for four surgical care access dimensions recommended by LCoGS: timeliness (proportion of population within 2 hours of a surgical care facility), capacity (met surgical need for major surgery operative volumes), safety (proportion of postoperative surgical site infections), and affordability (proportion of surgery-seeking households facing catastrophic expenses). ZVASCI (0=worst, 100=best) was defined as the normalized composite of these dimensions synthesized using adjusted Mazziotta-Pareto Index (AMPI) methodology, making it partially compensatory, easily calculable and interpretable, and comparable across space and time. We undertook extensive sensitivity analyses with several proxy variables for access dimensions, investigated spatial correlations across districts using Moran's I and checked for associations between ZVASCI and SDG index for 90 Aspirational Districts needing developmental push.

**Findings:**

ZVASCI was estimated for rural regions of 587 districts and 36 states/union territories (UTs). Among districts, Bhopal in Madhya Pradesh had the highest index value of 92.68 while North

and Middle Andaman in Andaman and Nicobar Islands had the lowest value of 0. Most districts had ZV-ASCI below 60. Among states/UTs, Chandigarh had the highest value of 77.29 while Andhra Pradesh had a null value. Most states had values in the 0-20 range. The sensitivity library consisted of 123,977 ZV-ASCI estimates. ZV-ASCI showed significant spatial correlation across districts (Moran's I = 0.22, p < 0.05) with clusters of low access. ZV-ASCI had small-sized non-significant correlation with SDG Index for aspirational districts (R = 0.18, p = 0.095).

### Interpretation:

The proposed index can encourage buy-in from policymakers and raise surgical care on the national agenda. Our methods have high translational value for global surgery research in low-and-middle-income countries. For India, these are the first such findings that can direct the development of a National Surgical, Obstetric, and Anesthesia Plan.

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None

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### BACKGROUND

- The Lancet Commission on Global Surgery- LCoGS (2015) estimated that over 5 billion people lack timely access to safe and affordable surgical care, globally (Meara et al., 2015). One-fifth were considered to be residing in South Asia, more specifically, India.
- While healthcare access and affordability problems are well-known in India particularly among its rural people, research and policy focus on surgical care is scant.
- We fill the research and policy gap by introducing a novel Zadey-Vissoci access to surgical care index (ZV-ASCI) estimated at state and district-levels for rural regions.

### FINDINGS

ZV-ASCI for 587 Districts & 36 States  
District with highest ZV-ASCI: Bhopal (92.68)  
State with highest ZV-ASCI: Union Territory of Chandigarh (77.29)

ZV-ASCI Correlation with SDG for Aspirational Districts  
N = 90, R = 0.19, p-value = 0.07

2 Spatial Autocorrelation of ZV-ASCI  
Global Moran's I = 0.221  
Pseudo p < 0.001

4 Sample snapshot of sensitivity estimates for Nagpur, Maharashtra

### METHODS

Dimension (Primary variable)	Sensitivity variables	Data Sources	Smallest possible analysis unit: District (n = 587) Time period: 2017-2018
<b>Timeliness (T<sub>i</sub>):</b> Proportion (%) of population within 2 hours of their nearest surgical care facility that can provide essential surgery.	T <sub>1</sub> : 30 mins. T <sub>2</sub> : 1 hour T <sub>3</sub> : 4 hours T <sub>4</sub> : 2 hours, facilities subset	IndoHealMap Surgical Geodatabase (ASAR, 2021); Malaria Atlas Project Friction surface rasters (Weiss et al., 2020); Urban-Rural Catchment Area (URCA) raster (Cattaneo et al., 2021); WorldPop; GADM 3.6	ZV-ASCI is a composite of 4 LCoGS-based dimensions (T, C, S, A). Ranges from 0-100 (0 = worst, 100 = best). Simple to compute & interpret. Partially compensatory Comparable across regions and periods Robust to outliers Non-controversial equal weights.
<b>Capacity (C<sub>i</sub>):</b> Met surgical need for the rate of major surgeries (requiring general or spinal anesthesia) relative to threshold rate of 5000 surgeries per 100,000 people (Rose et al., 2015)	C1: Total (major + minor) surgeries C2: Select major surgeries C3: C-section at 10% institutional deliveries threshold	Health Management Information System (HMIS); URCA; WorldPop; GADM 3.6; Guilmoite & Dumont (2019)	Normalization for <b>+ve</b> polarity: Timeliness, Capacity $T_{ij} = \left( \frac{x_{ij} - x_{2.5}}{x_{97.5} - x_{2.5}} \right) \times 100$ Normalization for <b>-ve</b> polarity: Safety, Affordability $S_{ij} = \left( \frac{x_{97.5} - x_{ij}}{x_{97.5} - x_{2.5}} \right) \times 100$ Aggregation $ZV-ASCI_i = \mu_i - (SD_i \times CV_i)$ Final ZV-ASCI (scaled: 0-100)
<b>Safety (S<sub>i</sub>):</b> Proportion (%) of post-operative surgical site infections (SSI) relative to total (major + minor) surgeries	S1: relative to major surgeries	National Sample Survey (NSS) 75th Round – Social Consumption: Health; Reserve Bank of India (RBI); GADM 3.6	Total index combinations: 200 (5 * 4 * 2 * 5) ZV-ASCI sensitivity library: 123,977 (200 * (36 states + 587 districts))
<b>Affordability (A<sub>i</sub>):</b> Proportion (%) of households with at least one surgical hospitalization case in the past year facing catastrophic health expenditure (CHE)	A1: CHE at 25% threshold A2: CHE at 40% threshold A3: CHE at 60% threshold A4: impoverishing Health Expenditure (IHE), OQPE > poverty line		

### CONCLUSIONS

ZV-ASCI can: 1) encourage buy-in from policymakers and raise surgical care on the national agenda, 2) be translated to other LMICs for global surgery research, 3) be used for monitoring in India's National Surgical, Obstetric, and Anesthesia Plan.