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 are 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 lowestvalue 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 ZVASCI estimates. ZVASCI showed significant spatial correlation across districts (Moran's I= 0.22, p<0.05) with clusters of low access. ZVASCI 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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