The IndoHealMap Project: A geospatial modeling study mapping timely access to healthcare in India

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Acknowledgements

Disclosures

- I have no financial disclosures relevant for the contents of this presentation. But …

- I serve on the ASAR Board and the Advisory Board of Nivarana.

- I am a doctoral student in Epidemiology at Columbia University NYC visiting researcher at the GEMINI Research Center, Duke University NC US.

- I am the Chair of Asia Working Group at the G4 Alliance, Fellow at Lancet Citizens' Commission, and a Member of the State Mental Health Policy Drafting Committee for the State of Maharashtra, India.

- Parts of the work presented today are available online:

Medical College Hospitals   **Rural Surgical Facilities (preliminary)**   **Zadey thesis**

Maharashtra Shocker: Parents forced to walk 15 km through muddy path with dead sons' bodies on shoulder

A Maharashtra couple tragically carried their deceased children 15 km home after they died from fever. The lack of timely medical care and ambulance services has drawn criticism, and a medico-legal case has been opened for further investigation.

Livemint

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Geographic Access as Moral Capital in Health Systems

"exploration of the values and norms and the expectations toward them (*moral capital*) that circulate in their healthcare systems. ... The ability or inability to access healthcare services within close **geographic proximity**."

Source: Bartosch et al. 2024

What is Geographic Access: Facility Density
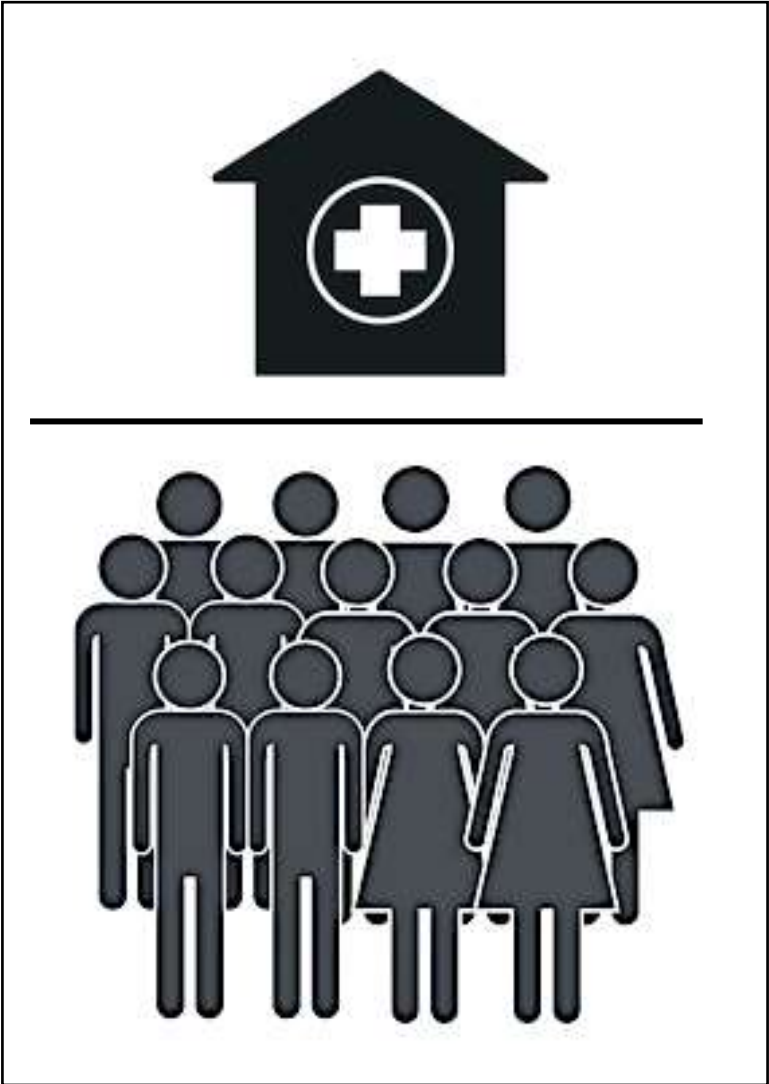
What is Geographic Access: Timeliness to Facility

Access Population Coverage

% Population in a region within X minutes of their nearest health facility

IndoHealMap
Mapping access population coverage for health facilities

Data collection

Data Analysis

General Data Background

- 300000+ health facilities of different kinds geolocated in India
- 10+ data sources
- 3+ years
- 20+ personnel
- Extraction → Standardization → Geocoding → Validation → Harmonization → Updating
- **Iterative scaffolding!**

Relying on global sources (& local modifications)

Malaria Atlas Project

Global maps of travel time to healthcare facilities

D. J. Weiss [1,2,3], A. Nelson [4], C. A. Vargas-Ruiz[1], K. Gligorić[5], S. Bavadekar[6], E. Gabrilovich [6], A. Bertozzi-Villa[1,7], J. Rozier[2], H. S. Gibson [1], T. Shekel[6], C. Kamath[6], A. Lieber[6], K. Schulman[8], Y. Shao[9], V. Qarkaxhija[10], A. K. Nandi [1], S. H. Keddie[2], S. Rumisha [1], P. Amratia[1], R. Arambepola[1], E. G. Chestnutt[1], J. J. Millar [1], T. L. Symons[1], E. Cameron[2,3], K. E. Battle[7], S. Bhatt [11] and P. W. Gething[2,3]

WorldPop

Revolutionary GIS

GIS for the people

Community Created Maps of India

Global mapping of urban–rural catchment areas reveals unequal access to services

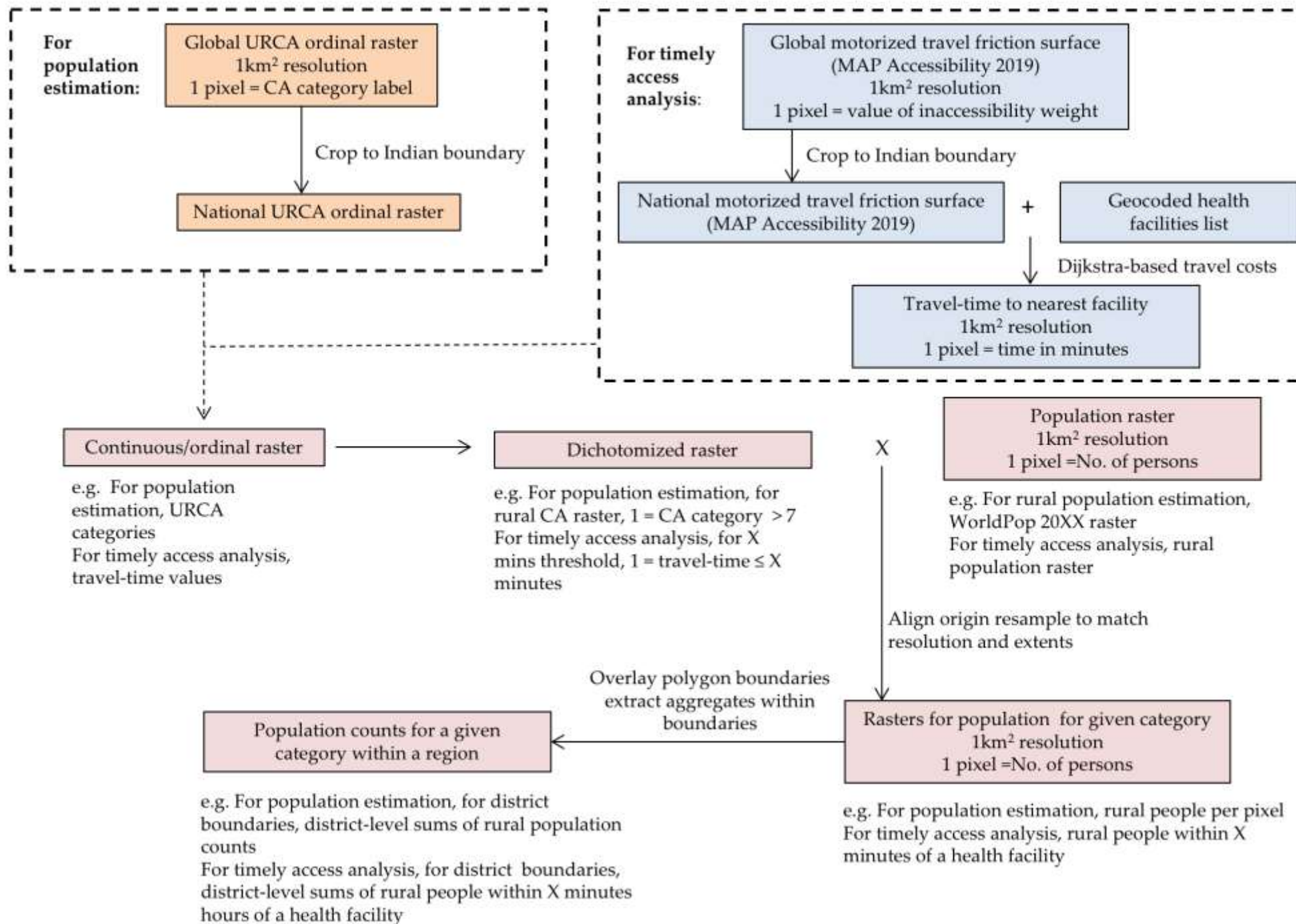Andrea Cattaneo [a,1], Andrew Nelson [b], and Theresa McMenomy [a]

URCA

ASAR

Analysis Pipeline

For population estimation:

Global URCA ordinal raster
1km² resolution
1 pixel = CA category label

↓ Crop to Indian boundary

National URCA ordinal raster

For timely access analysis:

Global motorized travel friction surface
(MAP Accessibility 2019)
1km² resolution
1 pixel = value of inaccessibility weight

↓ Crop to Indian boundary

National motorized travel friction surface
(MAP Accessibility 2019)

\+

Geocoded health facilities list

↓ Dijkstra-based travel costs

Travel-time to nearest facility
1km² resolution
1 pixel = time in minutes

Continuous/ordinal raster → Dichotomized raster

e.g. For population estimation, URCA categories
For timely access analysis, travel-time values

e.g. For population estimation, for rural CA raster, 1 = CA category >7
For timely access analysis, for X mins threshold, 1 = travel-time ≤ X minutes

X

Population raster
1km² resolution
1 pixel =No. of persons

e.g. For rural population estimation, WorldPop 20XX raster
For timely access analysis, rural population raster

Align origin resample to match resolution and extents

↓

Rasters for population for given category
1km² resolution
1 pixel =No. of persons

e.g. For population estimation, rural people per pixel
For timely access analysis, rural people within X minutes of a health facility

Overlay polygon boundaries extract aggregates within boundaries

Population counts for a given category within a region

e.g. For population estimation, for district boundaries, district-level sums of rural population counts
For timely access analysis, for district boundaries, district-level sums of rural people within X minutes hours of a health facility

Scope of Findings

Modes of travel								
Walking				Motorized transport				

Time Thresholds (mins)				Time Thresholds (mins)				
15	30	45	60	30	60	90	120	240

✖

Health Sector Split	
Public	Private

Area/Region Split	
Rural	Urban

Geographic Hierarchies
National
States/Union Territories (36)
Districts (735+)

E.g., **36000+** estimates for a health facility type - tertiary hospitals

Access to Primary Health Centers
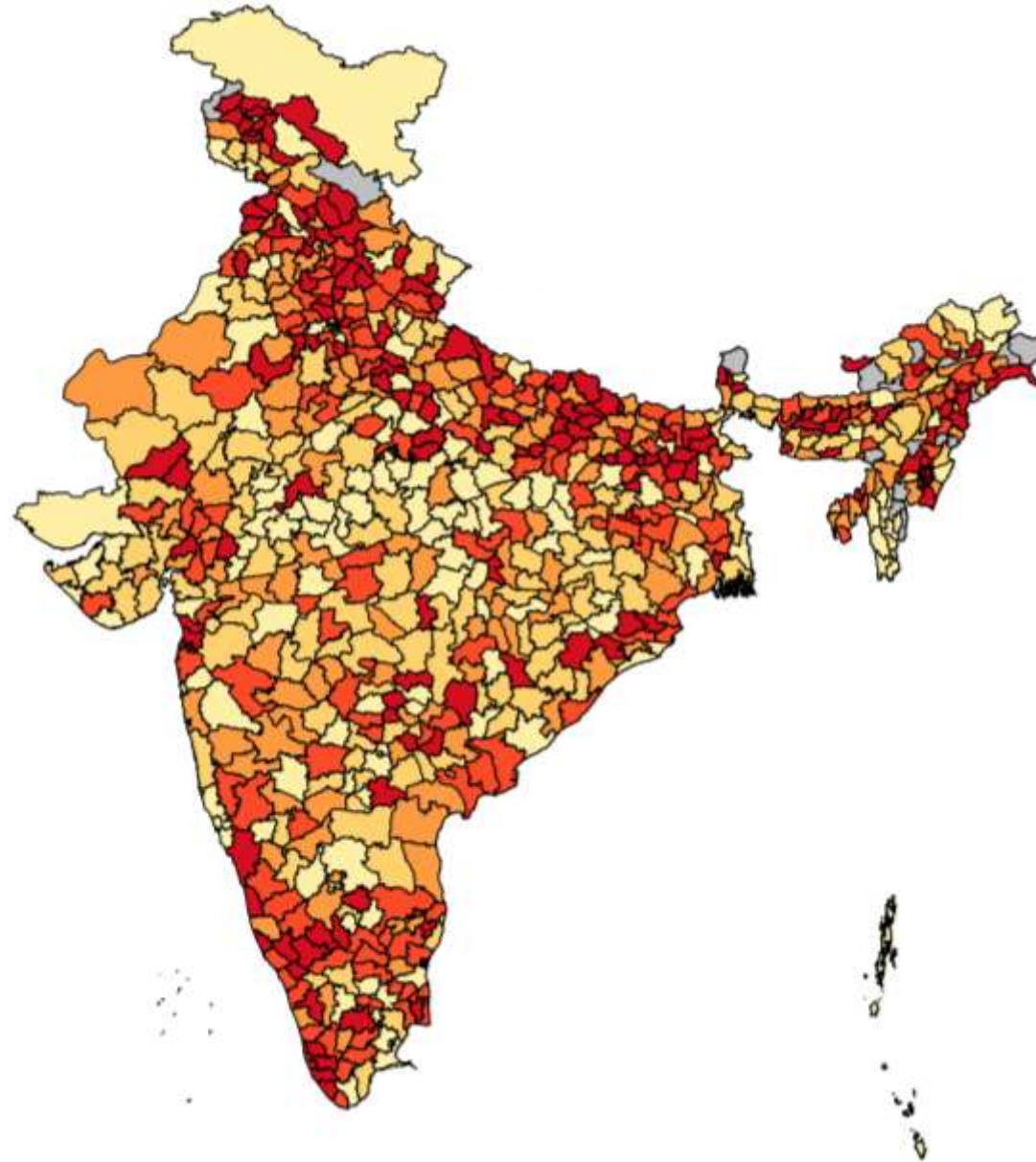
% People within 30 mins
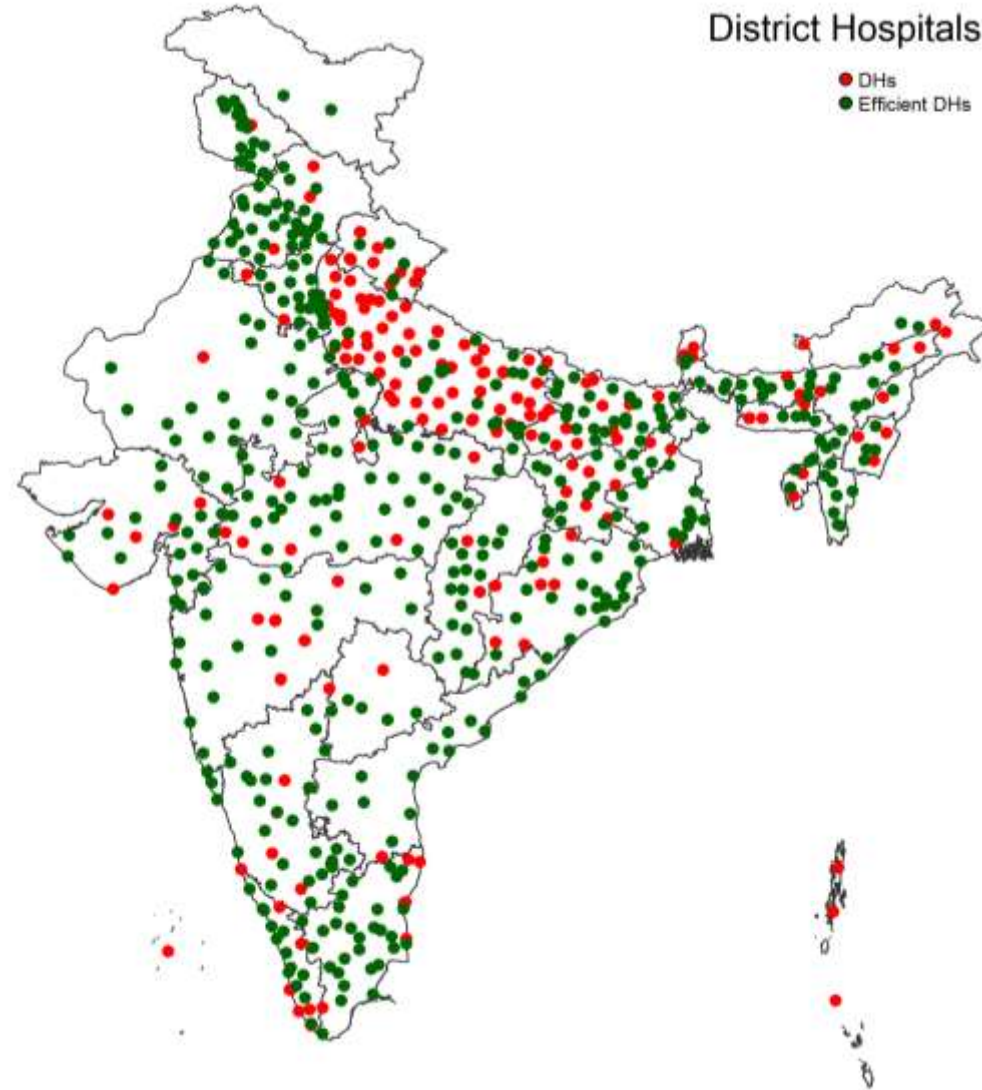of walking from their
nearest PHC

	0.0 to 10.7
	10.7 to 17.3
	17.3 to 24.3
	24.3 to 35.6
	35.6 to 100.0
	Missing
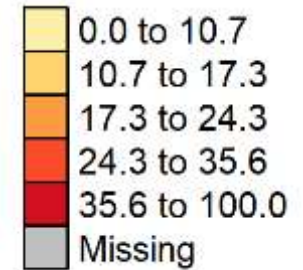
Access to Community Health Centers
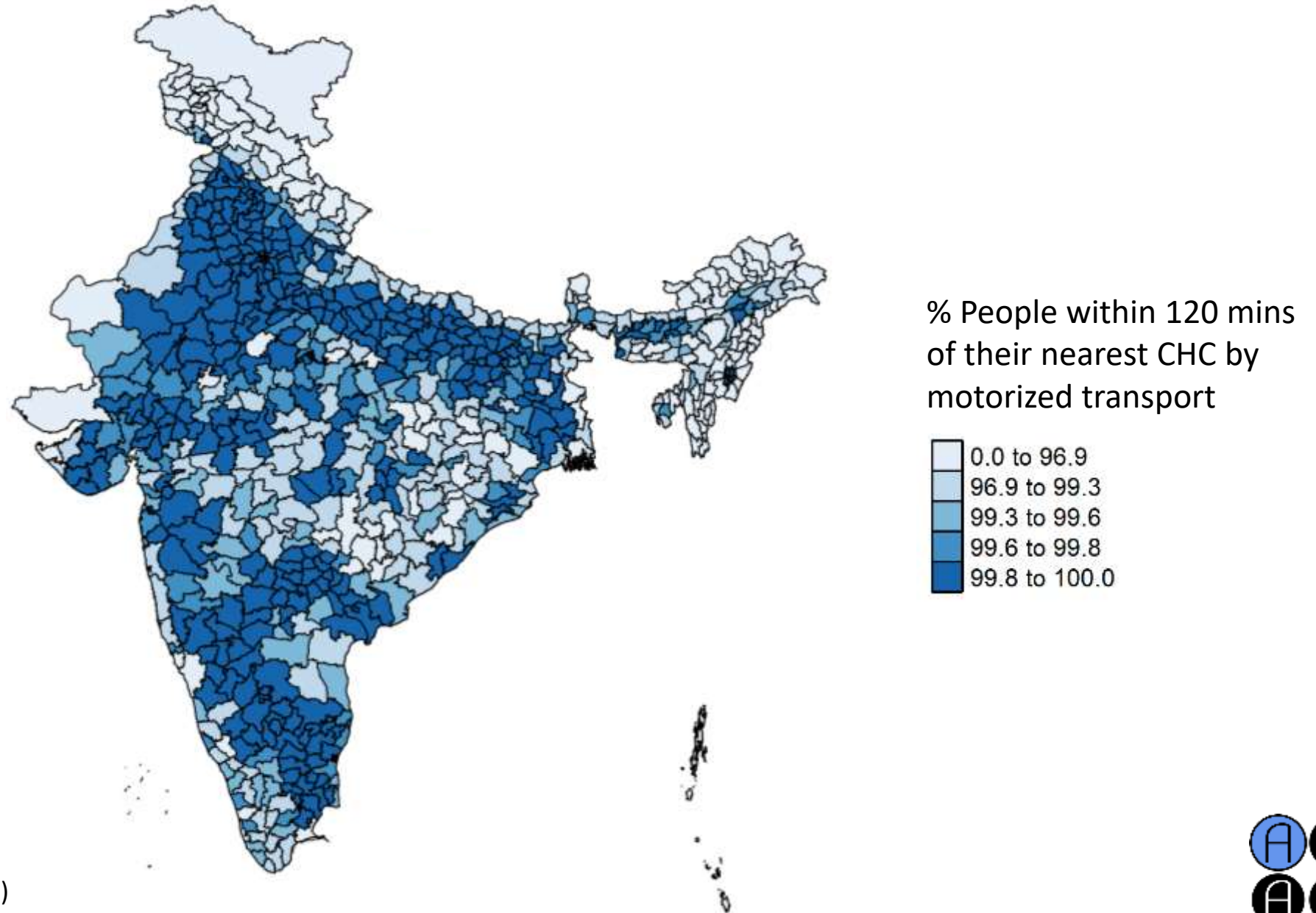
% People within 120 mins of their nearest CHC by motorized transport

0.0 to 96.9
96.9 to 99.3
99.3 to 99.6
99.6 to 99.8
99.8 to 100.0

Surgical Care Access to Efficient District Hospitals

District Hospitals
● DHs
● Efficient DHs

Source: Zadey et al. 2024 (under review)

Surgical Care Access to Efficient District Hospitals

All DHs

Efficient DHs

Mins to their nearest DH by motorized transport

- 0 to 30
- 30 to 60
- 60 to 90
- 90 to 120
- 120 to 240
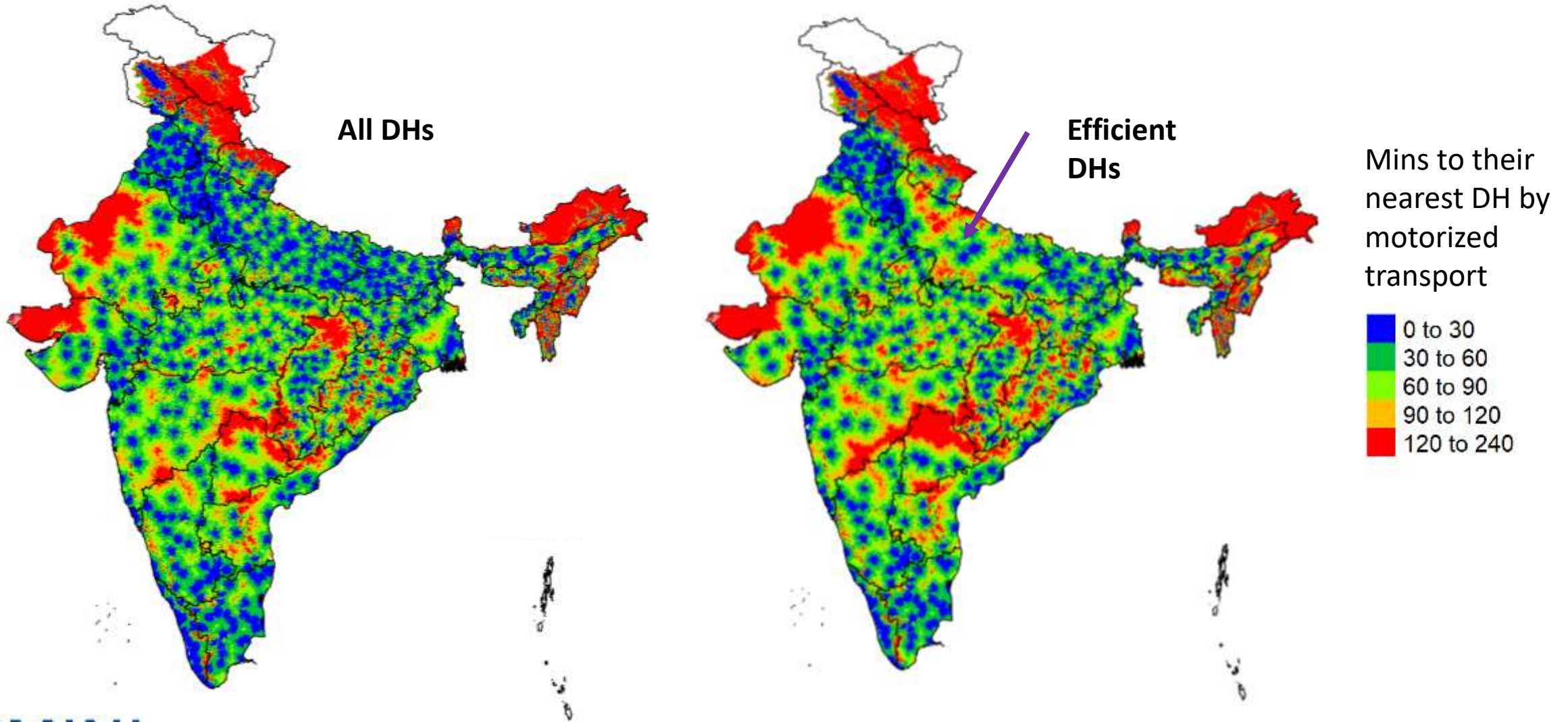
GEMINI

Global Emergency Medicine
Innovation & Implementation
Research Center

Source: Zadey et al. 2024 (under review)

Surgical Care Access to Efficient District Hospitals
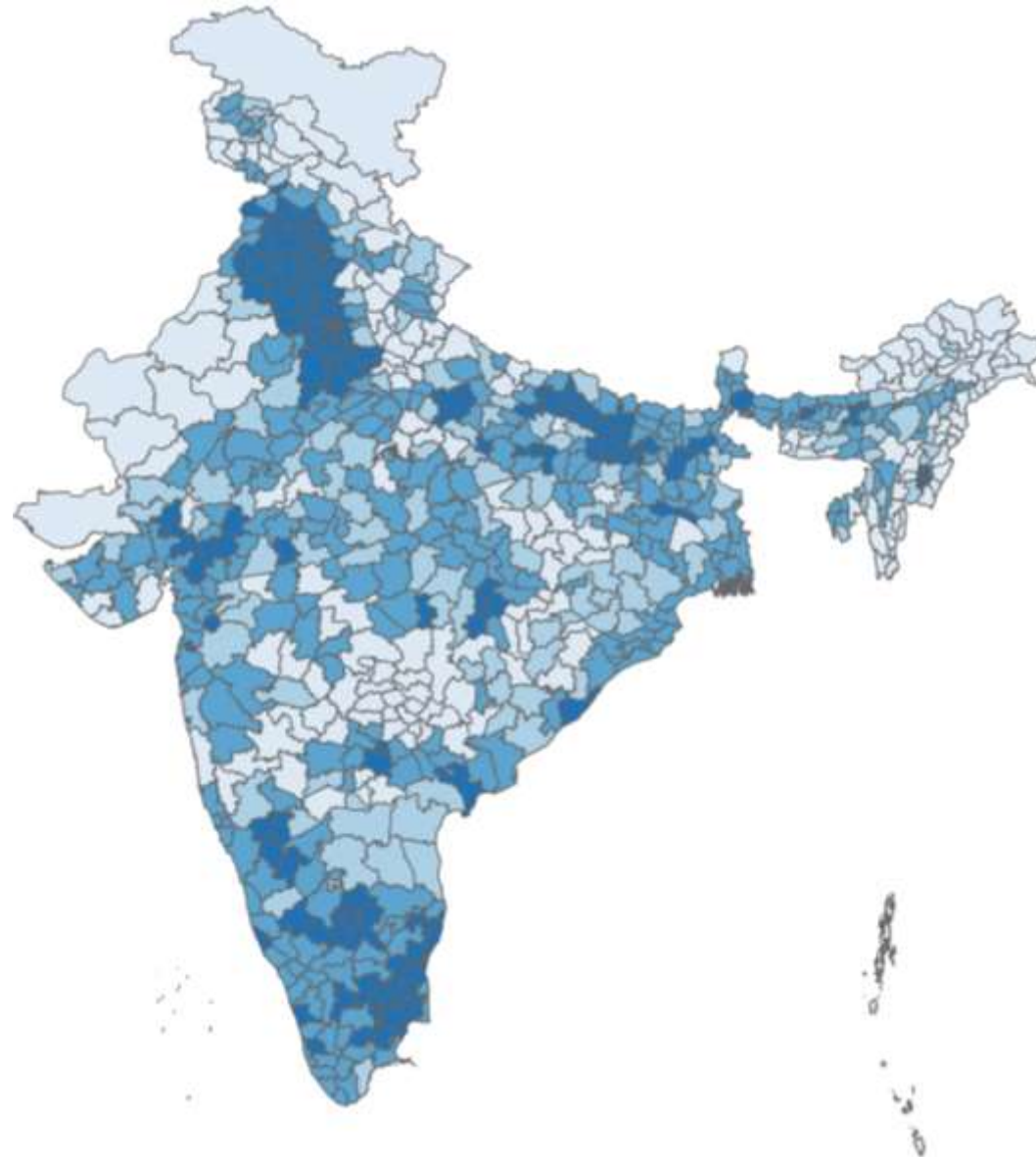
% People within 90 mins of their nearest DH by motorized transport
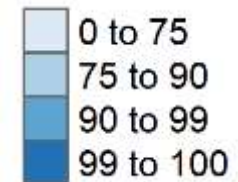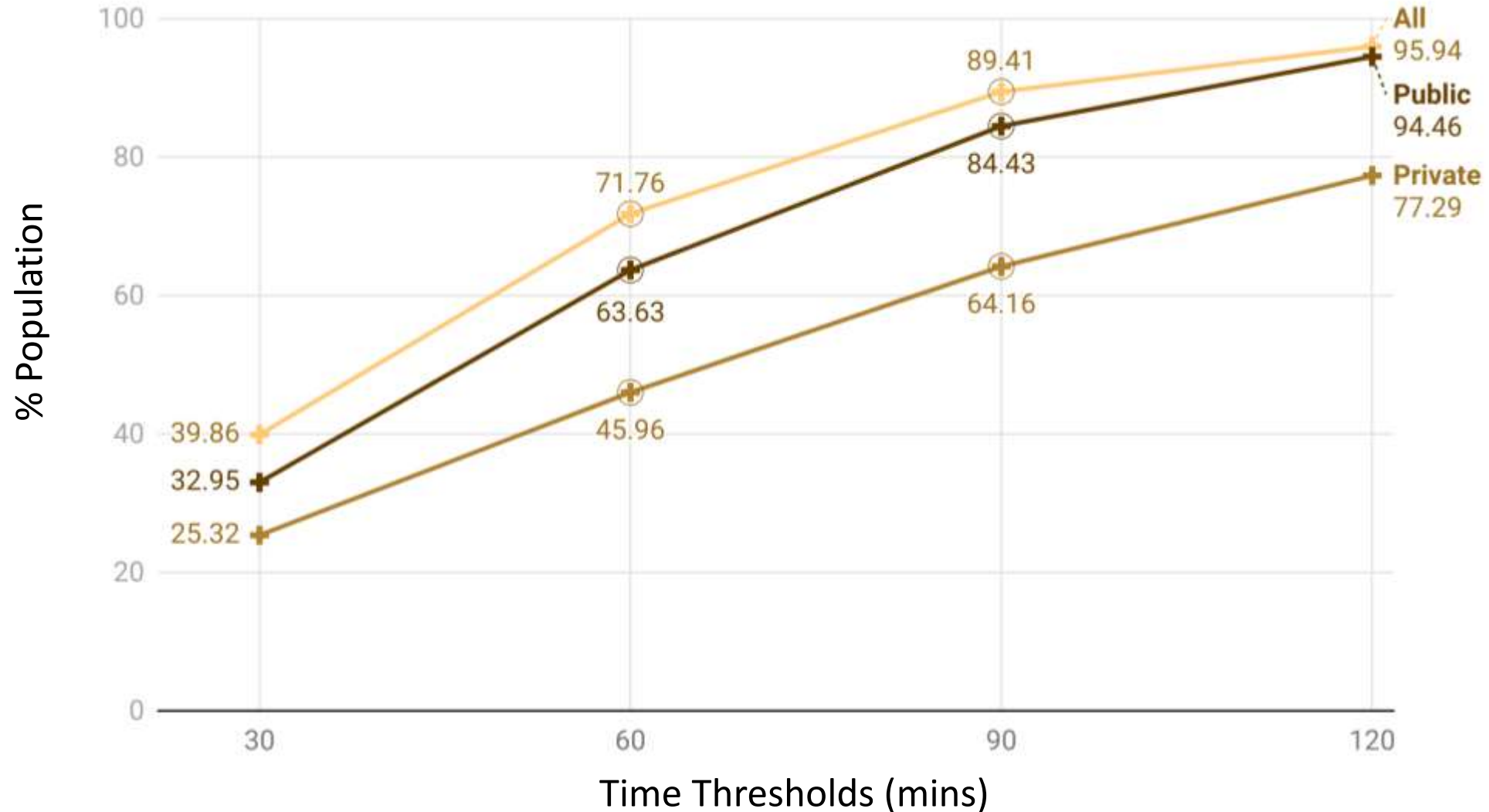
0 to 75
75 to 90
90 to 99
99 to 100

GEMINI
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Research Center

Source: Zadey et al. 2024 (under review)

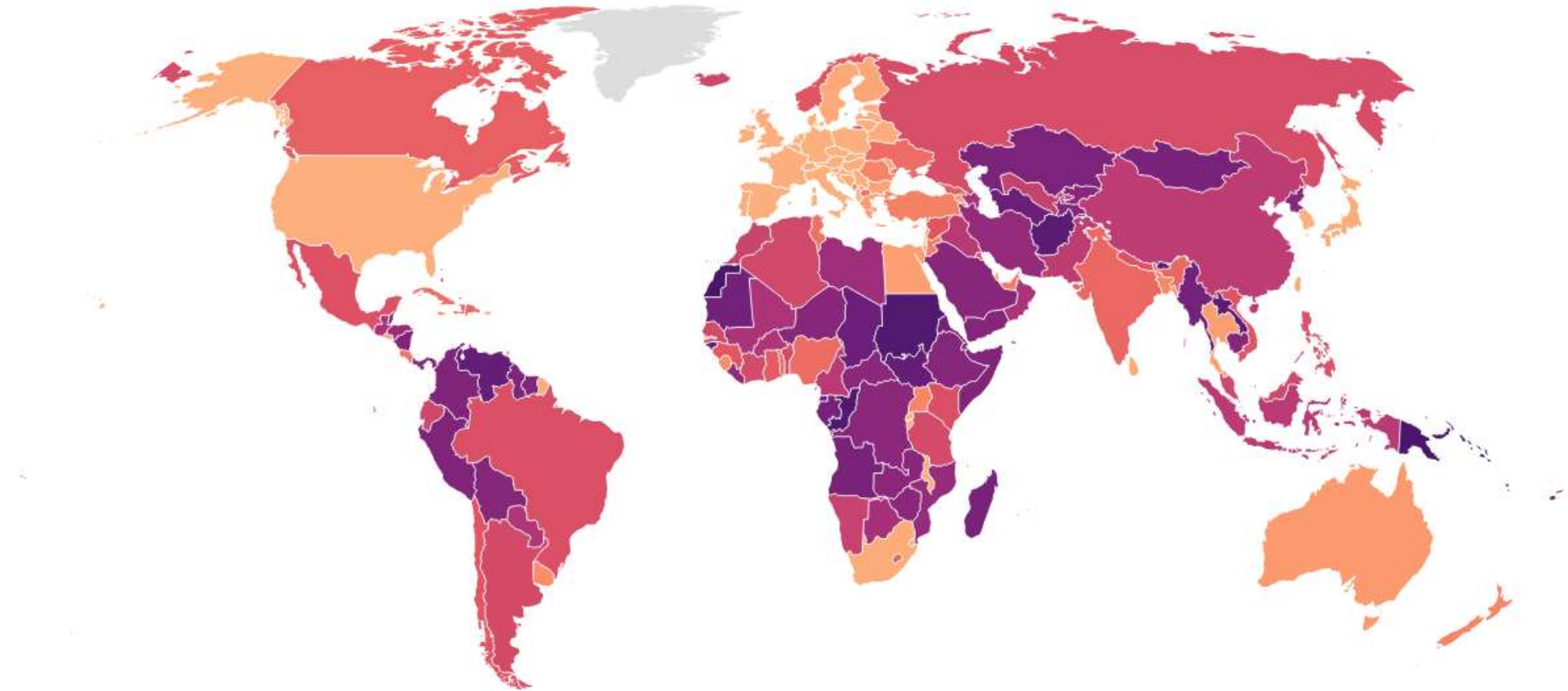# Access to Medical College/Teaching Hospitals

Source: Thakkar et al. 2024 (under review)

Rural-Urban Access Disparities In India
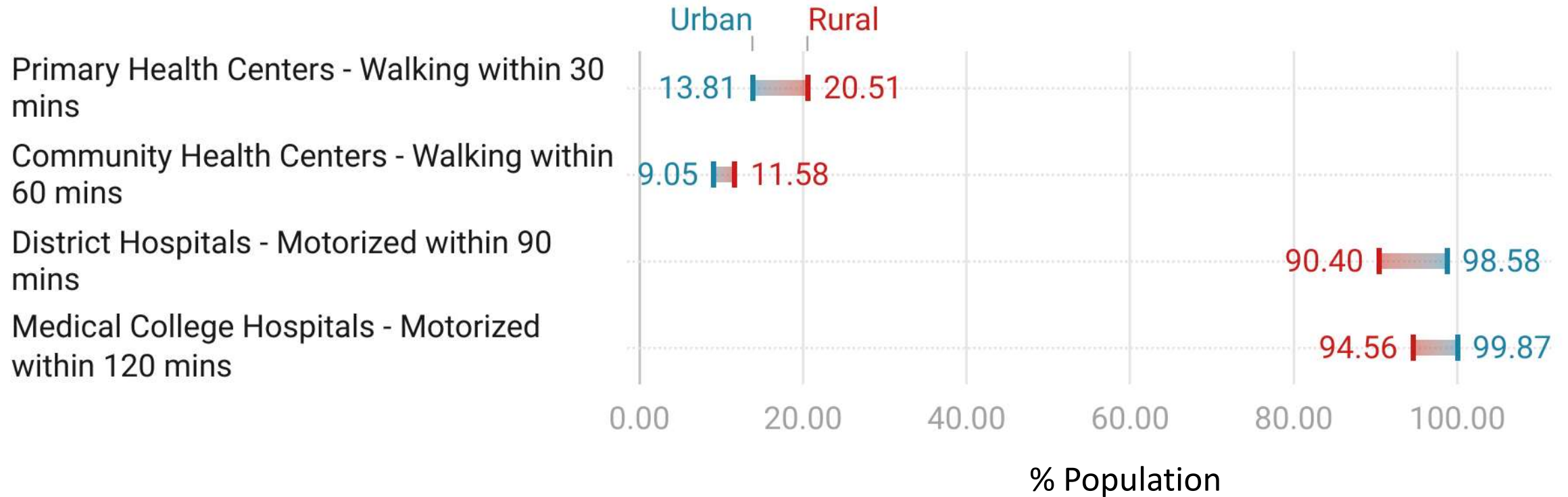
Global Rural-Urban Disparities in Access

Diff. in Urban & Rural population %

−9.01%　　　　　89.58%

Motorized travel within 60 mins

Expanding to Specialized Care Domains

Road Ahead

- **Methods improvements**
  - Floating catchment area models
  - Uncertainty estimation
  - Ground validation

- **Implications**
  - Incorporation of access population coverage in SDGs
  - Access disparities for policy prioritization
  - Inaccessibility deserts for local resource allocation for infrastructure

Thank You!

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