GIS in Strategic Health Service Planning: A Systematic Review of Access-Oriented Applications in Primary Care

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Importance of Primary Health Care

- All people, everywhere, have the right to achieve the highest attainable level of health. This is the fundamental premise of primary health care (PHC).
- Primary health care is a whole-of-society approach to effectively organize and strengthen national health systems to bring services for health and wellbeing closer to communities.
  - prevention ,promotion, treatment , rehabilitation and palliation
- First point of contact
  - general practitioners, nurses, midwives, and community health workers
- Promotes both equity and efficiency in health systems
- COVID-19 exposed system gaps → need for resilient PHC

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Primary Health Care and Universal Health Coverage

“Health for all” aspiration articulated at Alma-Ata Declaration in 1978

- Emphasized **Primary Health Care** = foundation of equitable health systems
- Evolved to Universal Health Care adopted by United Nations embedded in Sustainable Development Goals (SDG 3.8)
  - To “achieve universal health coverage, including financial risk protection, **access** to quality essential healthcare services, and access to safe, effective, quality and affordable essential medicines and vaccines for all” by 2030.

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Access?

- Accessibility refers to the ease with which individuals can obtain necessary medical services without barriers, encompassing physical, financial, and digital access.
- It ensures that care is available, affordable, and acceptable to all, regardless of disability, location, or socioeconomic status.
- Key determinant of population health

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Dimensions and Types of Access

- Five Dimensions(Penchansky & Thomas):
- Availability, Accessibility, Affordability, Accommodation, Acceptability
- Access is ***multidimensional***:
- Spatial (distance, location)
- Non-spatial (income, culture, education)
- Inequalities persist due to supply–demand mismatch

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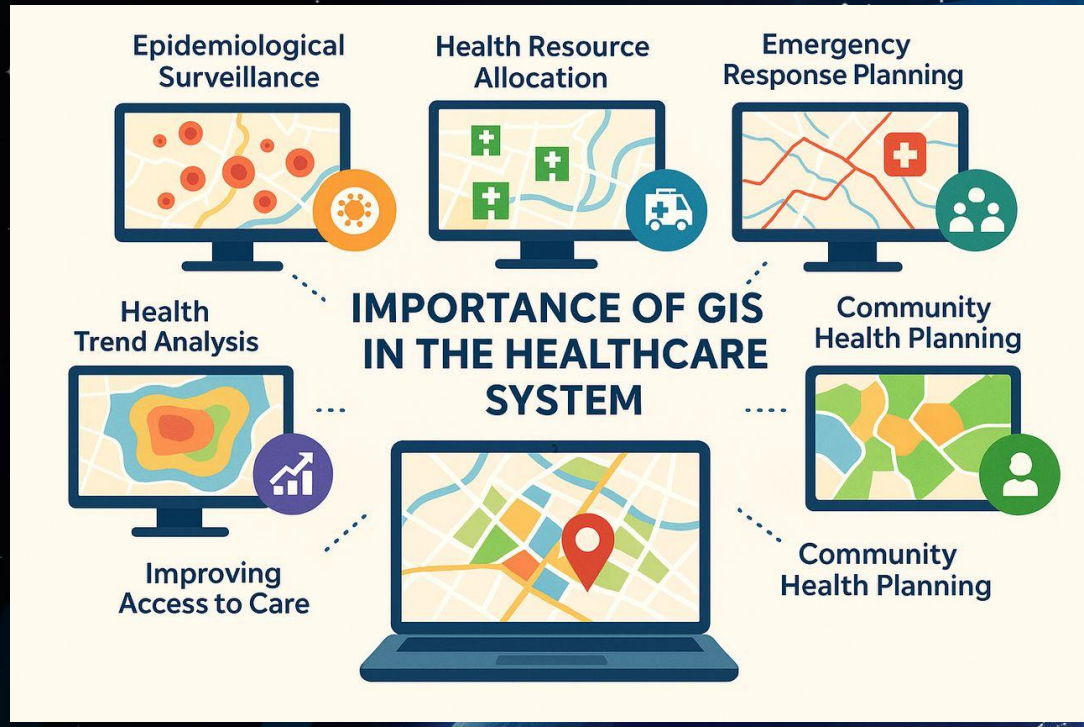
Why GIS?

Geographic Information Systems (GIS) = key tool in health planning

- Integrates spatial + non-spatial data
- Distinguish between potential and revealed accessibility
- Identifies underserved areas
- Informing health service planning
- Supporting equitable resource allocation.
- Important for rural & disadvantaged populations



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Search Strategy & Study Selection

PubMed, EMBASE, SCOPUS (inception → Aug 2025)

➢ Keywords combined:

- GIS terms: “GIS”, “spatial analysis”, “geospatial”
- Primary care terms: “primary health care”, “general practice”

➢ Screening:

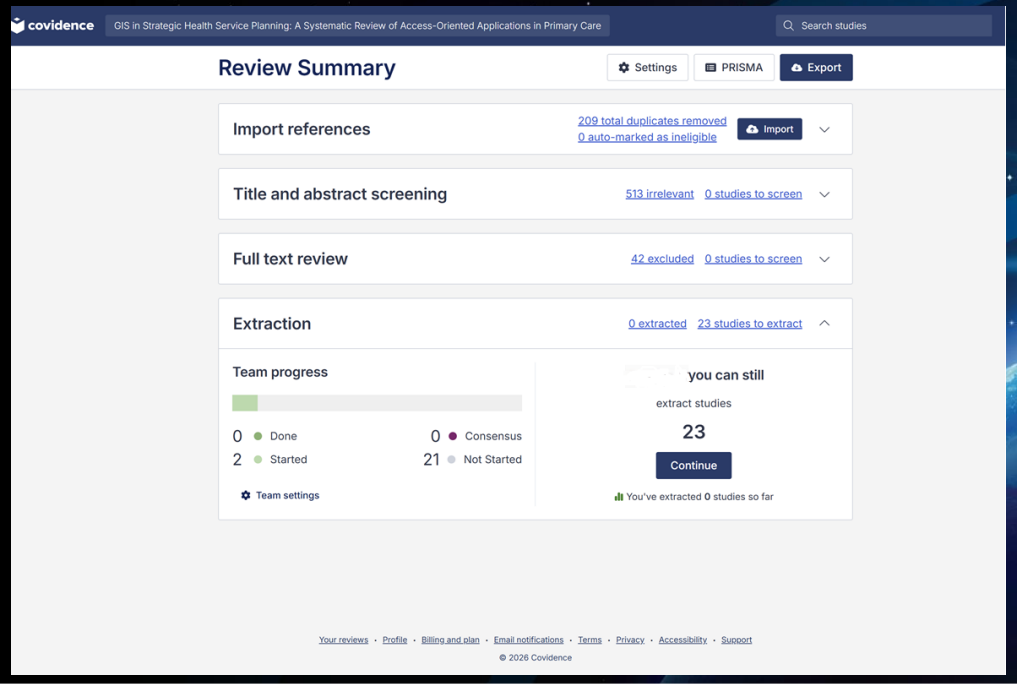
- Conducted by 2 independent reviewers
- Tool: **Covidence**

➢ **Full-text review + reference screening**

➢ **Disagreements resolved by third reviewer**

➢ **Followed PRISMA**

➢ **Registered in PROSPERO (CRD420251121520)**



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Eligibility Criteria & Data Extraction

✓ Inclusion Criteria:

- Studies using GIS/spatial analysis for primary care access
- All designs (quantitative, qualitative, reviews, models)
- Human populations
- English language (2015–2025)

✕ Exclusion Criteria:

- Non-primary care (e.g., hospitals only)
- Disease mapping without access focus
- Editorials, abstracts, grey literature, non-human studies

Data Extraction:

- Done independently by 2 reviewers
- Extracted:
  - Author, year, country
  - Sample size
  - GIS methods used
  - Key findings

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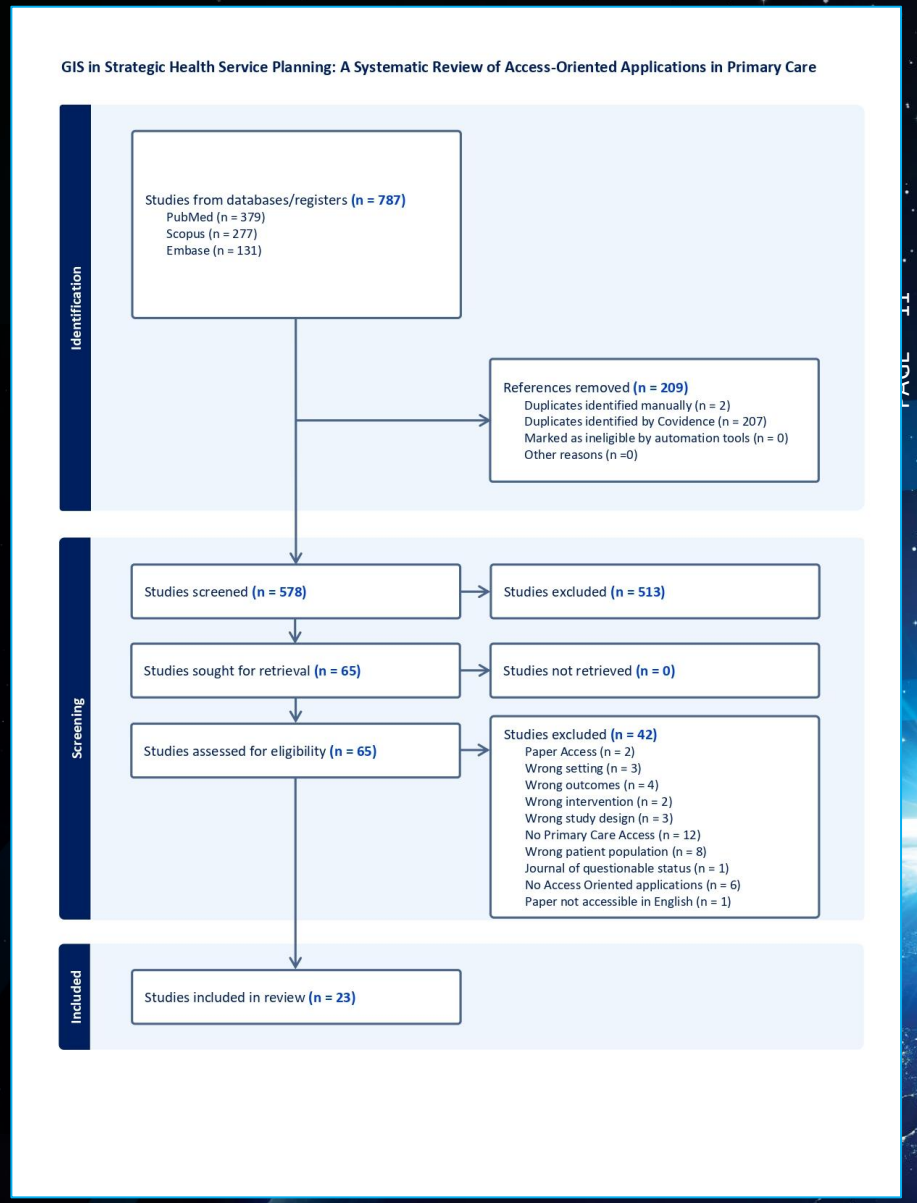
Literature Search Results

- Records identified: 787
- After duplicates removed: 578
- Full-text assessed: 65
- Excluded: 42 (various reasons)
- Final included studies: 23

Study Characteristics

- 23 studies (2015–2025)
- Covered 18 countries
- Included:
  - High-income
  - Low- & middle-income countries
- Main finding: Inequalities in PHC access are global
- Most used method: Floating Catchment Area (FCA)



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Identified GIS Methodologies

1. FCA Methods (most common)

- 2SFCA & extensions (E2SFCA, iFCA, Gaussian)
- Combine:
  - Supply (facilities capacities)
  - Demand (population size)
  - Distance between them

2. Proximity & Network Analysis

- Distance to nearest PHC provider
- Travel time analysis (e.g., ArcGIS)
- Limitation: ignores capacity & competition

3. Advanced & Innovative Approaches

- Patient-centered metrics:
- Travel time + waiting time
- "Bypass" behavior:
- Patients don't always use nearest facility
- Optimization models:
- Location-allocation (improve service placement)

💡 Key message: Moving from measuring → optimizing access

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Regional Variations in Access

1. The Universal Urban-Rural Divide (consistent finding)

- Disparity between urban and rural accessibility
- Rural = poorer access (especially in LMICs)

2. Regional and Socio-Economic Disparities within Countries

- Example: China (East vs West differences)
- Deprived urban areas may have better spatial access

3. Topography and infrastructure matter

- Poor road networks, rivers, mountains, roads, distance ↑ travel time
- Simple distance measures often misleading

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Conclusions

- Spatial inequalities in PHC access are **global and persistent**
- **GIS** effectively identifies these inequities
- **2SFCA** is the most widely used method for measuring access
- **Key Insight:**
  - Need to move beyond *potential* → *realized* access
  - Best approach combines:
    - Travel time modelling
    - Facility capacity data
    - Patient-centered factors
- **Future Directions:**
  - Integrate:
    - Dynamic & real-time data
    - Multi-modal travel scenarios
    - Non-spatial factors (affordability, quality and patient choice)

Take-home Message: GIS can support **equitable PHC planning** and advance **Universal Health Coverage & Sustainable Development Goals**

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