Geographic Disparities in Access to Assisted Reproductive Technology Centers in China: Spatial-Statistical Study

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Abstract

Infertility is emerging as a significant public health issue, particularly in China. The travel time and associated costs frequently impose a substantial burden on Chinese infertility patients. In this study, we utilized a web-based path planning engine to assess and visually represent the accessibility and travel costs to Assisted Reproductive Technology (ART) centers across mainland China. The distribution of ART centers in China is quite uneven. 76.8% of the population and 63.5% of the residential points were not accessible to an ART center within 1-hour. 76.8%, 39.5%, 70. 5%, 70. 5% and 41.7% of China's population can reach nearest ART center for Artificial Insemination by Husband, In Vitro Fertilization and Embryo Transfer, Intracytoplasmic Sperm Injection, and Preimplantation Genetic Diagnosis in an hour respectively. The resulting "Travel Time Map to ART centers in China" can help to estimate whether individuals will seek ART healthcare when it is needed, as well as providing an evidence base for efficiently distributing limited ART resources to underserved populations both now and in the future.

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Original Manuscript

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Objective

Infertility is growing as a serious public health problem[1]. The World Health Organization (WHO) reported in 2023 that infertility affects about 17.5% of the adult population globally[2]. Infertility problem is also prominent in China, with nearly 50 million people facing the problem[3]. However, the travel time and costs are often a significant burden faced by infertility patients [4,5]. In this study, we used a web path planning engine[6] to explore the spatial-economic disparities in access to ART centers in mainland China.

Study Design

The National Health Commission of the People's Republic of China supplied the list of ART centers, while population data was sourced from the 2020 Worldpop dataset[7]. Residential point locations were gathered from the Gaode Maps Open Platform. After retaining one residential point within a 1-kilometer radius, a total of 57,469 residential points were acquired. We opted for a contemporary approach by leveraging real-time traffic data from web map navigation services, a departure from traditional methods.. Employing the Path Planning 2.0 algorithm, we determined optimal paths between each residential point and the nearest ART center, predicting detailed travel time and corresponding costs. We averaged the travel times and costs of residential points within the county, thus representing the overall level of that county. Subsequently, isochronous maps depicting 1-hour and 2-hour travel times for ART services were generated.

Ethical Considerations

This study utilizes deidentified publicly available datasets released for public consumption, all of which are aggregated at the county level. We obtained full approval from the Institutional Review Board (IRB) for conducting secondary analyses of publicly available anonymized and de-identified datasets. These datasets contain no personally identifiable information and pose no risk of ethical violations.

Results

As of June 2022, a total of 543 healthcare institutions in Mainland China have received approved to conduct ART. However, only 55 institutions, constituting 10.1% of the nation, offer all five types of ART services. The distribution of ART centers in China predominantly favors the eastern plains and coastal regions (Figure 1A). Among the seven geographical subregions of China, East China boasts the highest number of ART centers, with a total of 162 (29.8%). Specifically, Guangdong province leads with the greatest number of ART centers at 10.3%, with 83.9% of the province's counties accessible to ART centers within 1.5 hours and an average taxi cost of merely 66.7 CNY (Chinese Yuan) [10]. In contrast, the Northwest region has the fewest number of ART centers, totaling 27 (5.0%). Tibet, in particular, has only one ART center, and a mere 12.2% of Tibetan counties have access to it within 1.5 hours, with taxi costs soaring as high as 1,485.2 CNY.

Travel time and costs to ART centers by province are presented in Table 1. Detailed information on travel time and costs is visualized in eFigure 1 and eTable. In China, a substantial portion of the population faces challenges in accessing ART facilities within a short timeframe. Specifically, 76.8% of the total population and 63.5% of residential points are not reachable to an ART center within an hour.

Discussion

The distribution of ART centers in China exhibits significant disparities. A higher concentration of ART healthcare centers is observed in urban and eastern regions, while individuals in northwestern and rural areas encounter prolonged travel times and elevated transportation costs when seeking ART treatment. The map serves the dual purpose of estimating the likelihood of individuals seeking ART healthcare when needed and providing an evidence-based foundation for the efficient allocation of limited ART resources to underserved populations, both in the present and future. The government is suggested to implement a series of measures, including counterpart aid and effective initiatives to educate and recruit ART doctors in disadvantaged units. Residents in rural and remote areas contend with extended travel times and substantial travel costs when accessing ART services, which should be covered fully or partially through travel subsidies or paid leaves. The introduction of telehealth services emerges as a viable solution to surmount these barriers for patients residing in remote areas, effectively reducing the necessity for in-person office visits. It is crucial to emphasize that ensuring privacy is paramount when helping patients seeking ART treatments. This study bears limitations. While we utilized the best available data, the residential point datasets remain susceptible to errors of omission. This algorithm confines the utilization to only one mode of transportation, a limitation that might not align with real-world scenarios. Additionally, individuals may not necessarily receive ART treatment at the nearest facility or may opt for alternative transportation means.

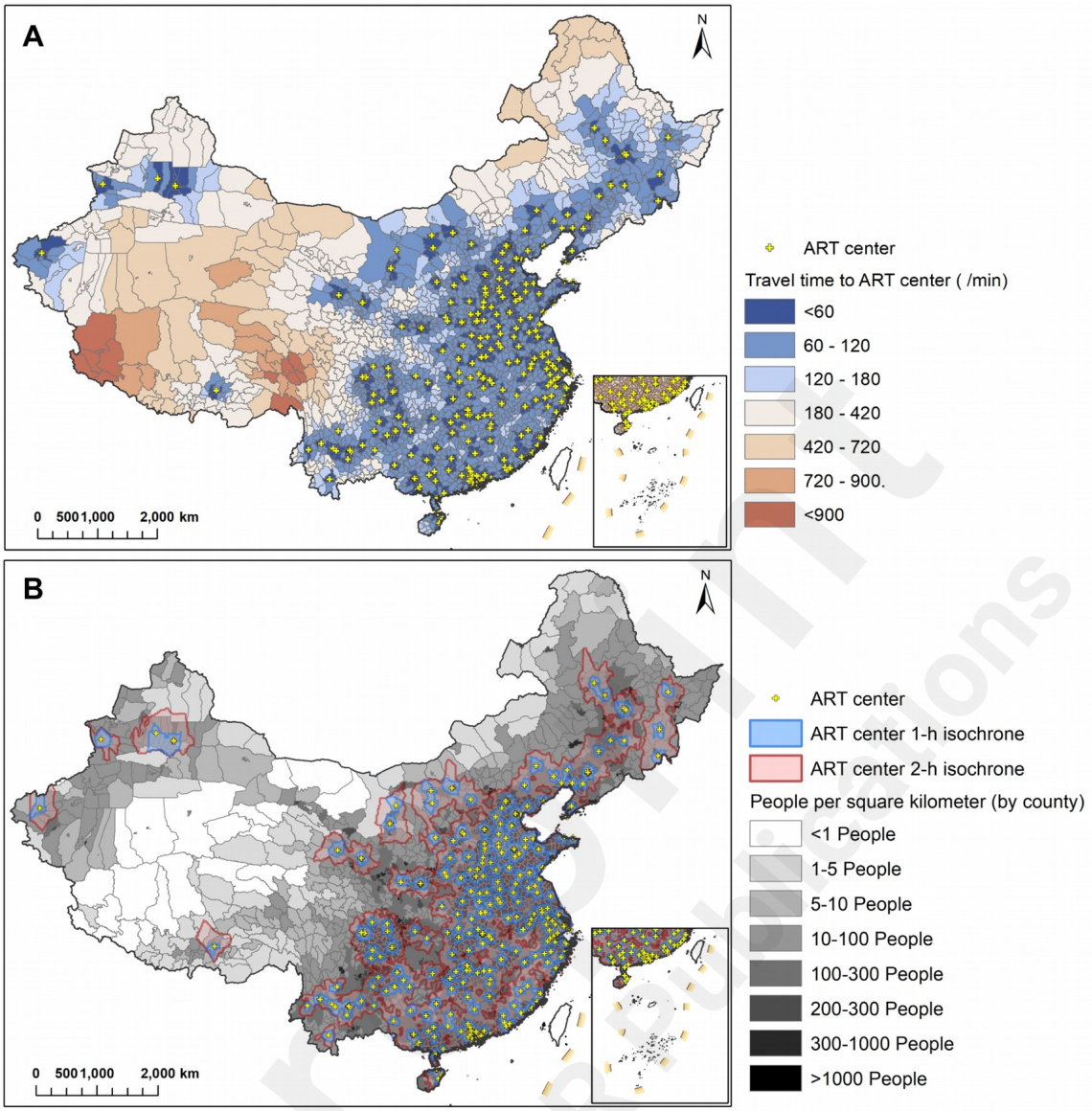

Figure 1. Travel time to assisted reproductive technology (ART) centers in China. *Panel A shows a map of travel times to ART centers at the county level; Panel B shows the population density of China's counties covering 1-hour and 2-hour travel time isochrones. Counties with higher population densities are shaded in dark gray. Areas shaded in red are located within the 1-hour and 2-hour travel time isochrones of the ART centers.*

Table 1. Travel Time and Travel Costs to ART Centers by Province and Proportion of Population Access to ART Services at Different Time Thresholds

Province	Number	Time (min)	Cost (CNY)	Population (%)		
				≤30 min	≤60 min	≤120 min
North						
Beijing	18	20.8	52.2	80.7	97.7	100
Tianjin	12	22.5	38.5	78.7	93.9	99.9
Hebei	31	43.0	93.1	44.3	75.5	94.1
Shanxi	12	45.0	112.1	49.2	65.1	96.7
Inner Mongolia	8	89.3	237.3	44.0	55.9	70.5
Northeast						
Heilongjiang	11	63.0	151.3	52.9	64.0	79.3
Jilin	9	72.4	153.3	40.0	52.3	77.3
Liaoning	19	47.5	90.3	44.1	69.4	94.9
East						
Shanghai	20	17.0	49.9	86.9	99.5	100
Jiangsu	33	38.0	71.6	42.9	83.8	100
Zhejiang	27	40.0	90.1	35.5	81.6	99.8
Anhui	16	44.8	101.8	46.2	63.2	97.8
Jiangxi	18	50.4	126.9	41.7	59.0	96.1
Shandong	32	38.1	90.0	44.1	79.5	100
Fujian	16	36.2	108.2	52.2	83.7	97.6
Central						
Henan	33	38.8	66.6	45.5	97.3	99.5
Hunan	24	52.0	121.0	39.2	59.8	95.6
Hubei	32	39.5	68.2	49.5	72.1	98.6
Southern						
Guangdong	56	27.7	66.7	67.6	91.2	99.5
Guangxi	21	42.3	102.0	53.0	65.1	98.0
Hainan	10	58.3	246.1	50.9	60.0	75.1
Southwest						
Chongqing	12	44.9	153.0	44.9	68.4	95.6
Guizhou	13	46.2	99.9	49.1	66.1	94.4
Sichuan	14	50.5	140.2	44.6	70.5	91.7
Yunnan	18	69.8	199.2	44.4	59.1	77.3
Tibet	1	267.9	1485.2	47.3	53.0	58.2
Northwest						
Ningxia	2	63.2	119.3	41.9	61.1	81.6
Qinghai	2	82.8	190.8	60.2	77.7	85.9
Gansu	4	131.9	157.1	29.5	32.6	49.3
Shaanxi	10	64.6	179.2	38.5	58.4	79.3
Xinjiang	9	108.4	275.5	56.3	61.5	67.1

Notes:

a. Travel cost is determined by the local taxi fare, which varies depending on the location. The first price covers a distance, often 2.5–3 km; every additional kilometer is then calculated at a certain price.

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Author Contributions
Dr. Zhu had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Concept and design: Zhu
Acquisition of data: Zhu
Statistical analysis: Zhou
Interpretation of data: Zhou, Zhu
Drafting of the manuscript: Zhou
Critical revision of the manuscript for important intellectual content: Zeng, Wu, Diao, He, Zhu
Obtained funding: Zhu
Administrative, technical, or material support: Zhu
Supervision: Zhu

Conflict of Interest
None reported.

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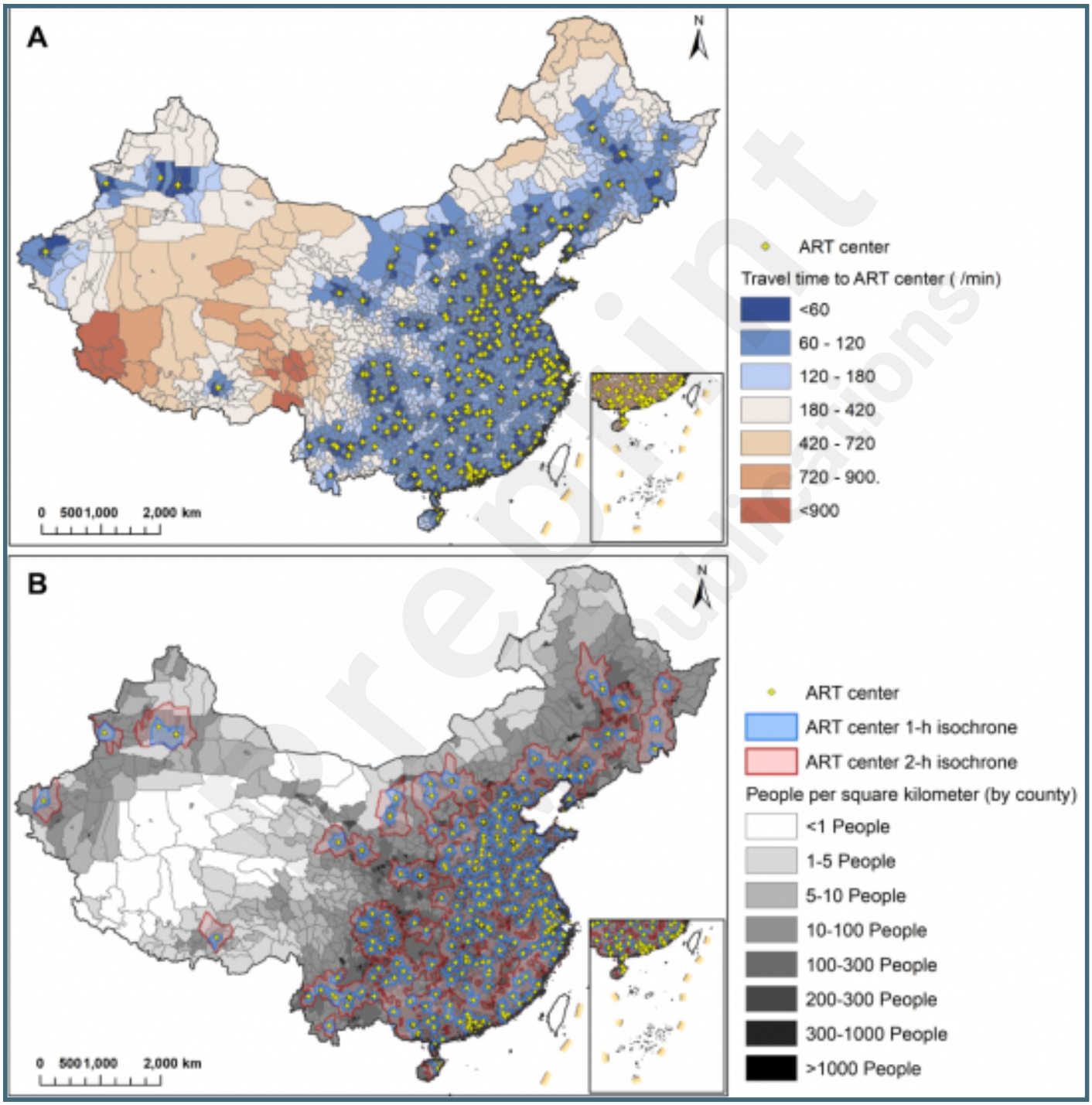
Role of the Funder/Sponsor
The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Supplementary Files

Figures

Travel time to assisted reproductive technology (ART) centers in China. Panel A shows a map of travel times to ART centers at the county level; Panel B shows the population density of China's counties covering 1-hour and 2-hour travel time isochrones. Counties with higher population densities are shaded in dark gray. Areas shaded in red are located within the 1-hour and 2-hour travel time isochrones of the ART centers.



Multimedia Appendixes

Supplementary Appendix.
URL: http://asset.jmir.pub/assets/fd449d684ab76795725beff3584bacb1.docx