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Community-Built Environment and Cardiovascular Disease Risk: Evidence from Multi-Source Data in Yangzhou

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Abstract: The spatial distribution of cardiovascular disease patients in Yangzhou City and the impact of different community environments was analyzed in this study. Spatial methods like kernel density analysis were used. Results show significant spatial clustering of cardiovascular disease patients within Yangzhou City. The study evaluates the impact of dining environment, culture and entertainment, healthcare, education, and technology on cardiovascular diseases. It was found that dining environment impacted people within a 500 m radius, while culture, healthcare, and education environments impact within 1 km. The influence of the industrial environment is smaller, requiring a 3 km range for significant effects. These findings aid urban planning and community development and helps in formulating measures to improve the residents' cardiovascular health.

Keywords: Cardiovascular disease; Community environment; Spatial distribution; Urban planning

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1. Introduction

Cardiovascular disease has become a serious non-communicable disease globally, especially in developing countries. As one of the largest developing countries, China has witnessed rapid socioeconomic development in recent years, leading to changes in lifestyle and an increasing risk of cardiovascular disease [1-3]. Therefore, controlling and preventing cardiovascular disease is crucial for ensuring public health.

Previous research has primarily focused on the impact of demographic characteristics, physiological factors, and behaviors on cardiovascular disease [4,5], exploring preventive or control methods. However, urban land scarcity in recent years has resulted in excessive development, reduced green spaces, and limited opportunities for sports and leisure activities. This resulted in changes in the residents' lifestyles, posing potential threats to their health. Consequently, attention has been drawn to the link between cardiovascular disease and urban environmental factors. To gain a deeper understanding of how multidimensional environmental factors influence cardiovascular disease, this study selected a typical metropolitan area in East China for research.

Therefore, the main focus of this study is on the following questions: (i) What is the distribution of cardiovascular disease in the city, and where are the key areas of high risk? (ii) Which environmental factors can be identified as significant influencers of cardiovascular disease classification? As a result, this study selects a typical metropolitan area in the East China region for research, aiming to deepen the understanding of how multidimensional environmental factors influence cardiovascular disease.

2. Materials

2.1. Study area

We selected Yangzhou City as our research area, an important city in Jiangsu Province and one of the renowned historical and cultural cities in China. As of the end of 2020, Yangzhou City has a total area of 6,591 square kilometers and a permanent population of 4.69 million, comprising six districts and counties, namely Hanjiang District, Guangling District, Jiangdu District, Gaoyou City, Yizheng City, and Baoying County [6]. Its longitude ranges from 119°01′ to 119°54′, and its latitude ranges from 31°56′ to 33°25′. The city's industrial development has generated numerous employment opportunities, attracting a large number of talented individuals to settle here. After decades of stable economic growth, Yangzhou City ranks among the top in terms of regional GDP nationwide.

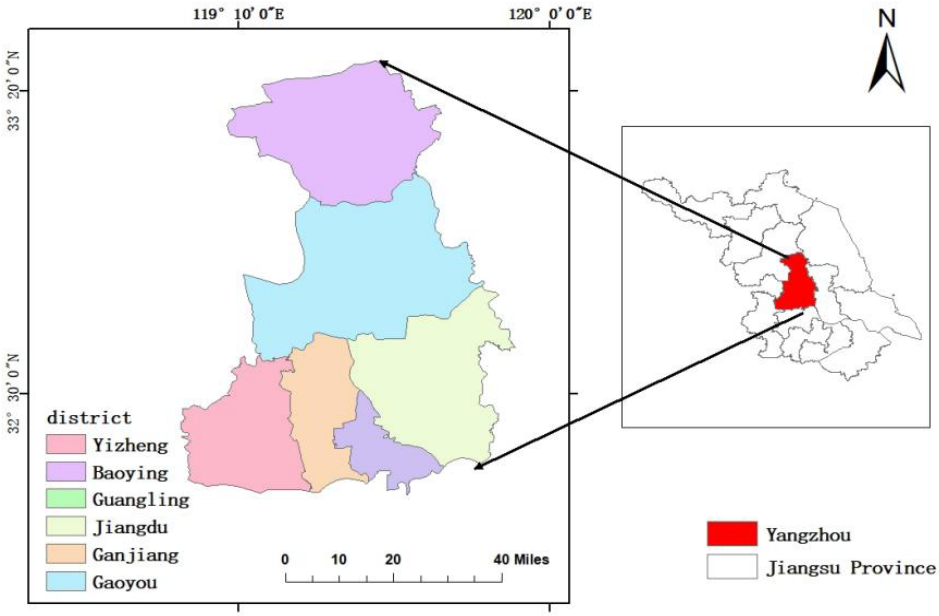

Figure 1. The study area of Yangzhou City

2.2. Data sources

In this study, we utilized multiple data sources, including cardiovascular disease data and point of interest (POI) data. The cardiovascular disease data were provided by a hospital in Yangzhou City and include disease types, age, gender, and addresses. In China, hospitals are classified into three levels based on their medical qualifications: Level One, Level Two, and Level Three [7]. Only major hospitals (Level Two and Level Three hospitals) are qualified to provide services for complex conditions such as cardiovascular diseases.

The point of interest POI data reflects rich urban facility information from a spatial perspective. In the study area, we collected approximately 280,000 POI data points. According to the department classification standards on the platform, we analyzed urban facilities or attractions, including dining, culture and entertainment, industrial, medical and health, and education and technology categories. We created 500 m buffers (approximately within a 10-minute walking distance), 1 km buffers, and 3 km buffers for each patient to

calculate the density of POIs [7]. These buffers represent the availability of urban facilities. **Table 2** summarizes the statistical data of all variables used in this study.

Table 1. Descriptive statistical analysis

	Frequency	Percentage
Cardiac vasculopathy (CV)	102	41.8
Structural and functional lesions of the heart (SFIH)	142	58.2
Total	242	100.0

Table 2. POI reorganization based on sectoral classification

Primary sectoral classification	Classification of secondary departments
Catering class	Chinese food, foreign food, snacks, coffee, dessert, tea house
Culture and entertainment	Sports, scenic spots, etc.
Industrial class	Industrial buildings, industrial parks, factories and so on
Medical and health class	Medical care, fitness, etc.
Education science and technology	Science and education, etc.

3. Result

3.1. Spatial analysis

Through kernel density analysis of cardiovascular disease patient data, we observed a pronounced clustering of cardiovascular disease patients, as shown in **Figure 2**. Building on this, we conducted statistical analysis on cardiovascular disease patients across various townships and streets. We computed the Moran's I index to analyze the spatial distribution of cardiovascular disease patients at the community level. The Moran's I index had a Z-score of 10.08, significantly higher than the critical value of 2.58, with $P < 0.01$. The Moran's I index was 0.399, indicating positive spatial correlation. This suggests that at the community level, cardiovascular disease risk exhibits a closely interconnected network structure.

We further employed hotspot analysis (Getis-Ord Gi*) within ArcGIS to explore local clustering. This analysis method allows for the identification of hotspots and cold spots of cardiovascular disease patients. The hotspot analysis revealed two high-value clusters and one low-value cluster. Guangling and Hanjiang districts each have a significant high-risk hotspot, while Baoying County represents a low-risk cluster (**Figure 3**).

3.2. *t*-test

We conducted independent-samples *t*-tests for cardiovascular disease patients. The results revealed significant spatial distribution characteristics of the impact of community environments on cardiovascular disease. Specifically, we found that the influence of dining environments on cardiovascular disease was mainly concentrated within a 500 m range, indicating that the dining environment within the community significantly affected residents' cardiovascular health (**Table 3**). Additionally, the impact of culture and entertainment, medical and health, and education, and technology environments was mainly within a 1-kilometer range (**Table 4**). The influence of industrial environments on cardiovascular health was relatively small and required a 3 km range to show a significant effect (**Table 5**).

Based on the comprehensive research findings, we emphasize the importance of planning in promoting residents' health and propose recommendations for optimizing resource allocation and creating a more comfortable and healthier living environment.

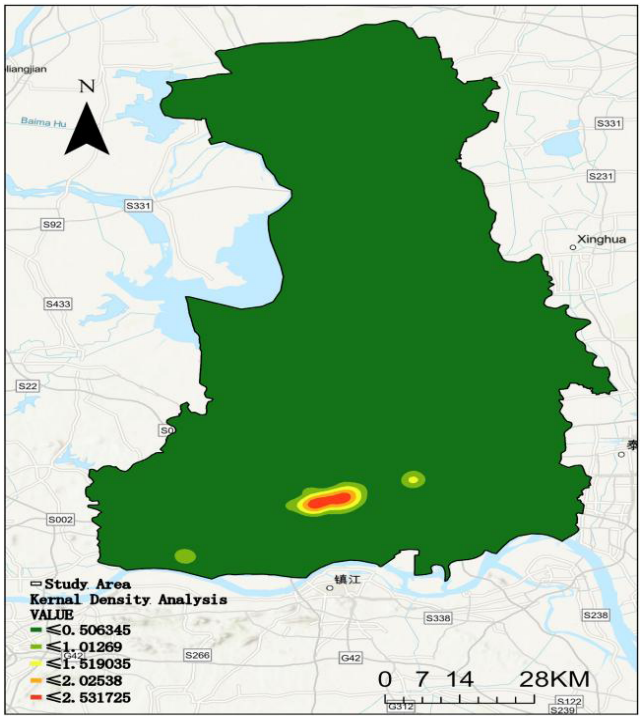

Figure2. Kernel density analysis

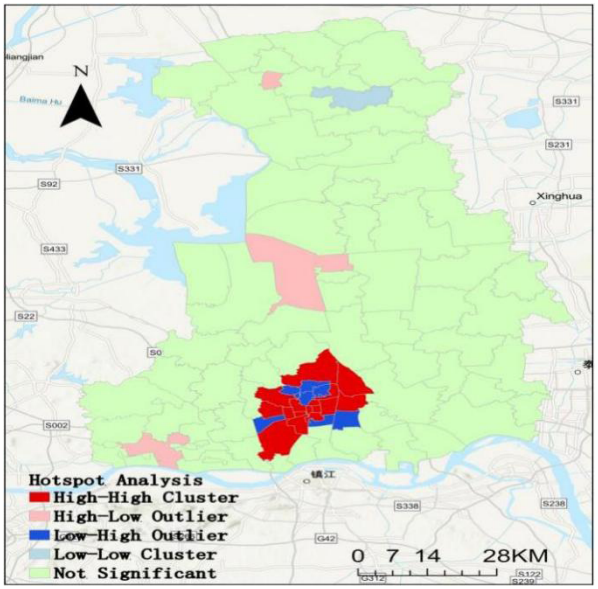

Figure3. High-risk communities for cardiovascular disease

Table 3. Buildings with different 500 m ranges

Building	CV	SFIH	*t*-test	
	Mean (SD)	Mean (SD)	*t*-value	Sig.
Chinese food	31.67 (3.472)	23.55 (2.363)	2.003	0.046
Foreign dishes	1.70 (0.377)	1.15 (0.224)	1.323	0.013
Snacka	5.24 (0.507)	6.70 (0.829)	1.499	0.036
Mousse	4.44 (0.545)	2.75 (0.412)	2.475	0.014
Teahouse	2.38 (0.250)	1.43(0.351)	2.676	0.008

Table 4. Buildings with different 1km ranges

Building	CV	SFIH	*t*-test	
	Mean(SD)	Mean(SD)	*t*-value	Sig.
Science education	4.44 (0.545)	2.75(0.412)	1.089	0.029
Literary form	7.41 (0.750)	6.08(0.845)	1.169	0.044
Park	1.80 (0.130)	1.12(0.125)	3.636	0.003
Gymnasium	9.61 (0.717)	7.30(0.766)	2.160	0.032

Table 5. Buildings with different 3km ranges

Building	CV	SFIH	*t*-test	
	Mean (SD)	Mean (S.D.)	*t*-value	Sig.
Industrial	10.76 (0.663)	8.52 (0.861)	2.094	0.037
Factory	24.91 (1.898)	19.70 (1.333)	2.245	0.026

4. Conclusion

In this study, kernel density analysis was performed to reveal a significant spatial clustering of cardiovascular disease patients in Yangzhou City. The study found that the catering environment within communities had a significant impact on residents' cardiovascular health. Additionally, the influences of cultural entertainment, healthcare, and education technology environments on cardiovascular disease were moderate, mainly concentrated within a 1 km radius and overlapping with cardiovascular disease hotspots. Industrial environments had a smaller impact on cardiovascular health, which only became evident within a 3 km radius. Planning should consider these environmental factors.

In conclusion, this study highlighted spatial variations in the impact of community environments on cardiovascular disease. Improving the dining environment, enhancing cultural entertainment, healthcare, and education technology facilities, and rational urban planning for industrial environments could potentially reduce CVD risks and improve residents' cardiovascular health. Future research should delve deeper into the relationships between these environmental factors and cardiovascular disease while expanding the scope of the study for more generalized conclusions.

Disclosure statement

The author declares no conflict of interest.

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