

Study on spatial differences of population aging in Yangtze River Delta region

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Abstract: Under the background of population aging, the Yangtze River Delta as a city cluster is a special area of aging. This study uses empirical method to explore the spatial distribution characteristics of aging among 41 cities in the Yangtze River Delta region. The results show that: from 2000 to 2015, the aging degree of 41 cities in the Yangtze River Delta region is deepening, from the early aging to moderate and deep aging, the aging degree of cities tends to be unbalanced, and the difference is increasing; Population aging develops rapidly, mainly at medium speed, but there are some differences between different regions in different periods.

Key words: Yangtze River Delta; Aging; Space

In 2000, our country entered the population aging society, and is on the fast track of the aging process at present. At present, China's rapid economic growth and continuous improvement of medical technology and equipment have made the life expectancy of the population continue to increase, coupled with the declining fertility rate. In the future, the aging problem will become a normal social phenomenon. As an economically developed area in China, the Yangtze River Delta city cluster takes the lead in population change and population age structure change. In 2019, the Outline of the Plan for the Integrated Development of the Yangtze River Delta Region elevated the integrated development of the Yangtze River Delta to a national strategy. This policy not only brings development opportunities to the Yangtze River Delta integration region, but also triggers new thinking on the aging problem in the Yangtze River Delta region.

Existing literatures focus on the spatial differences of aging at the national, provincial, city and county levels, while few studies on urban agglomerations. CAI Yuanfei et al. (2016) pointed out that the current spatial distribution of aging in China is "from east to west", with a large difference in the eastern part. Nie Qian et al. (2023) used exploratory spatial analysis to analyze the spatial situation of aging in Henan province. Yuan Jun (2007) emphasized that the aging phenomenon is aggravating not only in urban areas but also in rural areas, and the regional imbalance is significant. Liu Tao et al. (2022) found that the aging effect of population mobility has significant spatial differentiation and agglomeration characteristics. Wu Yuanyuan et al. (2021) found that population aging in Northeast China presents a spatial pattern that gradually deepens from west to east and from north to south. To sum up, urban agglomerations are a collection of cities and a special region for population aging. Therefore, it is of great significance to explore the spatial distribution characteristics of population aging in the Yangtze River Delta.

I. Research design

1. Study Area

The Yangtze River Delta region has a pivotal strategic position in China due to its strong innovation ability, high level of economic development and perfect social security such as medical care. Its GDP accounts for about one quarter of its GDP. However, the aging situation in the region is severe, and the aging among cities shows non-equilibrium. Based on this, this paper takes the whole Yangtze River Delta region as the research object, and focuses on the analysis from the prefecture-level city level, a total of 41 cities.

2. Data sources

From 2000 to 2015, the number of prefecture-level cities in Jiangsu and Zhejiang remained at 13 and 11, while Anhui province changed by one, from 17 in 2000 to 16 in 2015. According to the data of the Ministry of Civil Affairs, PRC, in July 2011, Anhui abolished the prefecture-level Chaohu city and set up a county-level Chaohu city, while the original districts and counties were divided into Hefei, Wuhu and Maanshan. In the specific research, this paper will adjust the data according to the actual situation. The main data sources in this paper include China City Statistical Yearbook, Zhejiang Statistical Yearbook, Jiangsu Statistical Yearbook, Shanghai Statistical Yearbook and Anhui Statistical Yearbook.

3 Measurement Indicators

(1) Absolute aging degree refers to the proportion of the elderly population, which can statically measure the aging situation of an area, the formula is:

$$\text{Absolute degree of aging} = \frac{a(65+)}{p} * 100\% \quad (1)$$

(2) The absolute difference of population aging degree is calculated by the coefficient of standard deviation (S) centered on the arithmetic mean, where N is the number of cities and the average aging coefficient. \bar{y} The larger the value of S, the greater the difference in the degree of aging among cities. The formula is:

$$S = \sqrt{\frac{\sum_{i=1}^N (y_i - \bar{y})^2}{N}} \quad (2)$$

(3) NICH index is the relative development rate index, which can compare the aging development speed between a certain city and the whole Yangtze River Delta region. The formula is as follows:

$$NICH = \frac{Y_{2i} - Y_{1i}}{Y_2 - Y_1} \quad (3)$$

In the formula, Y_{2i} and Y_{1i} respectively represent the population aging coefficient of a city in the Yangtze River Delta at time 2 and time 1, and Y_2 and Y_1 respectively represent the average population aging coefficient of the Yangtze River Delta at time 2 and time 1. When the NICH value is greater than 1, it indicates that the urban population aging growth rate is higher than the overall average level in the Yangtze River Delta region.

II. Analysis of empirical results

1. Spatial difference of population aging degree

The absolute aging degree of 41 cities is calculated according to formula (1), and according to the United Nations population age structure classification method, namely, young (<4%), adult (4%-7%), early aging (7%-10%), moderate aging (10%-14%) and deep aging (>14%).

Spatially, from 2000 to 2015, the aging degree of all cities in the Yangtze River Delta has deepened, from early aging to moderate and deep aging, among which Maanshan City has the largest increase (greater than 7%). However, cities are different, and the aging degree of most cities is deepened. Only Suzhou, Bozhou and Huaibei have no change in the types of cities, and they are always in the early stage of aging.

In terms of time, in 2000, the aging type was mainly early aging, only two cities of Huaibei and Tongling were adult aging, and four cities of Taizhou, Lishui, Shanghai and Nantong were moderate aging. In 2005, most of the regions entered the stage of moderate aging, the number of cities increased from 4 to 26, accounting for 62% of the whole, 15 cities were early aging, only Nantong entered the deep aging stage. In 2010, there were 16 early aging, 24 moderate aging, the number decreased by 2, and the number of deep aging increased to 2. Taizhou entered the stage of deep aging from moderate aging. It is worth noting that the 8 cities of Nanjing, Wuxi, Hangzhou, Wenzhou, Jiaxing, Shaoxing, Jinhua and Taizhou decreased from moderate aging to early aging. On the one hand, the aging coefficient decreased due to the large number of young migrants in the cities, but it cannot explain the decrease in the degree of aging in these cities. In 2015, the degree of moderate aging increased to 29 cities, accounting for 71 percent of the total cities, and the depth of aging was 8 cities, an increase of 8 cities from 2000. It can be seen that from 2000 to 2015, the degree of aging in the Yangtze River Delta region was deepening, and the aging of 41 cities increased greatly, from the early aging to the moderate and deep aging.

To further analyze the differences in the degree of population aging, the absolute differences of population aging in 41 cities were measured according to formula (3). On the whole, the absolute difference coefficient (S) from 2000 to 2015 was 0.79, 1.06, 0.89 and 1.57, respectively, and the value increased significantly. In 2015, it was twice as large as that in 2000, indicating that the urban difference of aging was expanding in the past 15 years. Specifically, Shanghai (1.22) and Anhui Huangshan (0.15) had the largest difference in 2000, with a difference of 1.07. Among them, the coefficient of 34 cities such as Suzhou, Nantong and Changzhou is more than 0.5, indicating that the absolute difference of population aging degree in these cities is large. In 2005 and 2010, the maximum values were Nantong (1.45) and Suzhou (1.58), respectively, and the difference between them was 1.19 and 1.33, and the absolute difference coefficients of 38 cities were greater than 0.8. In 2015, Suzhou had the highest absolute difference coefficient of 2.13, while Wuhu had the lowest absolute difference coefficient of 1.11. At the same time, the index values of both cities were more than 1, which means that the absolute difference of population aging degree of the cities was large.

2. Spatial difference of population aging speed

In 2000, China entered the age of population, but the time of entering the age is different, and the aging speed is also different. The relative Development Rate index measures the growth rate of 41 cities from 2000 to 2015 relative to the overall aging of the Yangtze River Delta region. Based on formula (3), the relative development rate (NICH) of population aging in each city is calculated, and combined with the actual situation, the NICH value is divided into 6 categories by 0, 0.5, 1, 1.5 and 2, and the results are shown in Table 1.

Table 1 Relative Development Rate of Urban Aging in the Yangtze River Delta

Category	NICH value	2000-2005.		2005-2010.		2010-2015.		2000-2015.	
		Number	proportion	Number	proportion	Number	proportion	Number	proportion
Negative Growth	N<0	1	2.38	21	50.00	0	0.00	0	0.00
Ultra Low Growth	0<N<0.5	5	11.90	3	7.14	9	21.95	6	14.63
Low Growth	0.5<N<1	14	33.33	5	11.90	11	26.83	19	46.34
Medium Growth	1<N<1.5	14	33.33	3	7.14	14	34.15	8	19.51
High Growth	1.5<N<2	8	19.05	2	4.76	4	9.76	5	12.20
Ultra High Growth	N>2	0	0	13	30.95	3	7.32	0	0.00

Overall, the 41 cities have different rates of aging. From 2000 to 2015, all cities were positive, meaning that the progress of aging was increasing in all cities. Among them, only 6 cities had ultra-low growth rate, and 4 cities (Lishui, Jinhua, Hangzhou and Ningbo) belonged to Zhejiang; Eight cities have high growth and rapid aging process, four cities (Yancheng, Yangzhou, Taizhou and Nantong) belong to Jiangsu Province, and three cities (Xuancheng, Huangshan and Ma 'anshan) belong to Anhui province; Shanghai is in the ultra-low growth rate, indicating that the aging process is slower than other cities. On the one hand, the aging degree is high in Shanghai at the beginning, and on the other hand, the population migration is dominated by young and middle-aged people.

From 2000 to 2005, the proportion of low-speed growth and medium-speed growth in the Yangtze River Delta cities reached 66.66%, with one negative growth and zero ultra-high-speed growth, indicating that on the whole, there was a growth trend, but the growth was slow. From 2005 to 2010, the negative growth accounted for half of the Yangtze River Delta cities, followed by the ultra-high-speed growth, accounting for 30.95%, indicating that the aging process of the cities is very different, there are two extremes of negative growth and ultra-high growth. From 2010 to 2015, the medium-speed growth ($1 \leq N < 1.5$) of cities in the Yangtze River Delta was the largest, accounting for 34.15%, followed by low-speed growth and high-speed growth. Overall, the aging progress was faster.

III. Research conclusions

In terms of degree, from 2000 to 2015, the degree of aging in the Yangtze River Delta region was deepening, from early aging to moderate aging and deep aging. At the same time, the absolute difference of population aging in the Yangtze River Delta region showed an expanding state, and the degree of aging among cities tended to be unbalanced, and the difference was increasing. In terms of speed, 41 cities in the Yangtze River Delta entered the aging stage earlier than the whole country, and the relative development rate index of all cities is positive, that is, the aging progress of all cities is increasing and accelerating, and the aging development speed is fast, but there are differences in different periods. The development speed is mainly medium-speed growth, accounting for 34.15%, followed by low-speed growth and high-speed growth.

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