

Travel Characteristic of Elderly People in Towns of Shanghai Metropolitan Area: An Urban-Rural Mobility Network Analysis

Ge Wan¹, Jianzhong Huang^{1,*}

Affiliation: ¹ College of Architecture and Urban Planning (CAUP), Tongji University, Shanghai, China

* Corresponding author.

Email: 2210273@tongji.edu.cn

Abstract

With the intensification of low birth rates and population aging in China, the proportion of elderly individuals is steadily increasing. Currently, research on the travel behavior of the elderly largely focuses on urban areas, with relatively limited attention paid to rural elderly populations. However, towns—which serve as a vital link between urban and rural areas—present more complex geographic, social, and transportation conditions that significantly impact elderly travel. This study employs network analysis methods, combining mobile signaling data with transportation survey data to deeply investigate the travel characteristics of township residents aged 65 and above in their daily lives. It also analyzes and summarizes the key influencing factors and proposes corresponding planning strategies.

Keywords: Elderly travel; Town; Urban-rural population mobility; Shanghai Metropolitan Area

1. Introduction

China's population development has entered a "new normal" phase, characterized by negative population growth, declining birth rates, an aging population, shrinking household sizes, and increasingly differentiated spatial distribution across regions (Liu, 2021; Qi, 2019). The country is transitioning from focusing on child-rearing to elder care, as the working-age population continues to decline and both demographic size and structure become more polarized. With these trends intensifying, the proportion of elderly individuals is steadily increasing, prompting the government to place greater emphasis on meeting the social needs of older adults.

In the Shanghai metropolitan area, Shanghai itself is not only the earliest city in China to enter an aging society, but also the one with the most severe aging level. Other cities in the region, such as Nantong, have also entered a stage of deep population aging. The growing travel demand of elderly populations makes building an age-friendly and inclusive society a key focus of urban and regional planning.

To date, most research on elderly travel behavior has concentrated on urban areas, with relatively little attention paid to elderly individuals in rural settings. Townships, which serve as critical links between urban and rural areas, face more complex geographic, social, and transportation conditions. Due to the frequent outmigration of younger labor forces, a significant number of elderly people are left behind in these townships. Compared to resource-rich urban areas, township-dwelling elderly populations deserve greater attention, which is an essential component of constructing an inclusive society. With the advancement of mobile signaling data, it is now possible to analyze the travel characteristics of rural elderly populations, offering a foundation for governments to allocate urban-rural resources more effectively and build an age-friendly society.

This study focuses on all townships within the Shanghai metropolitan area. Using network analysis methods and integrating mobile signaling data with transportation survey data, it constructs urban-rural and rural-rural population mobility networks. The study deeply explores the travel characteristics of township residents aged 65 and above in their daily lives and examines the relationship between these characteristics and the socioeconomic development of the townships. It identifies the main influencing factors and attempts to provide a clearer understanding of the spatial mobility and cross-regional interactions of elderly people from the perspective of population mobility networks. The findings reveal the specific needs and behavioral patterns of the elderly in townships, offering insights for differentiated planning tailored to the unique characteristics of elderly populations across different regions. This will support government efforts to improve transportation infrastructure, enhance social support services, and optimize medical resource allocation—contributing to the development of an inclusive society and addressing the challenges of population aging.

2. literature review

In the context of an increasingly aging population, the daily activity patterns and travel convenience of the elderly have drawn significant attention from scholars both domestically and internationally. Unlike younger age groups who often occupy a more “mainstream” position in society, elderly individuals tend to have lower incomes and diminished physical capacities. As a result, they rely more heavily on public service systems, healthcare systems, and social welfare programs. This dependence contributes to a range of “social isolation” issues faced by the aging population.

Unlike other countries, elderly travel behavior in China is influenced by its unique social environment, leading to distinct patterns. In recent years, there has been a growing body of research focused on the travel behavior of older adults in China. For example, Zhang et al.(2007) used travel survey data from Beijing residents to compare the travel characteristics (including travel rate, time, distance, mode, and purpose) of elderly individuals aged 61–65 with those of people aged 19–60. They also examined how travel modes and purposes change with age and analyzed differences in travel behavior between elderly residents of central and non-central urban areas at a spatial level.

Similarly, Hu et al.(2013) conducted surveys and analyses of elderly travel behavior in Changchun, exploring aspects such as travel frequency, travel purpose, and mode choice. They compared travel behavior in developing and developed countries, identifying the causes of differences, and proposed urban transportation policies to improve the travel frequency and comfort of the elderly. These policy recommendations included the integration of transportation and land use planning, improvements to pedestrian infrastructure, and enhanced accessibility of public transportation services. Zhang et al.(2019) argued that issues such as traffic congestion, complex traffic environments, and poor travel comfort for the elderly have long been neglected. To address this, they applied a Nested Logit model to study the travel patterns of the elderly in Beijing, finding that public buses play a crucial role in elderly mobility.

When it comes to analyzing the factors that influence elderly travel behavior, the literature points to a combination of socioeconomic conditions, external environmental factors, and policy-related influences. Socioeconomically, studies have shown that age, gender, education level, income, car ownership, and household size significantly affect elderly travel behavior. In terms of the external environment, factors such as population density, diversity, urban design, destination accessibility, and distance to public transit also impact travel decisions. From a policy perspective, welfare initiatives targeting the elderly—such as free or discounted public transportation and improved accessibility through barrier-free infrastructure—can significantly encourage elderly use of public transit and enhance social inclusion, thereby helping to mitigate social isolation (Zhang, 2019).

Overall, existing research on elderly travel characteristics tends to focus primarily on urban populations, with limited attention given to elderly individuals living in townships. There is also a lack of analysis concerning the mobility characteristics of elderly populations moving between urban and rural areas. Moreover, while many studies rely on statistical or travel survey data, fewer incorporate big data approaches, such as mobile signaling data, which could offer deeper insights into travel patterns.

3. Methodology and data

The Shanghai Metropolitan Area, located in eastern China, is a key component of the Yangtze River Delta region. The planning area encompasses the “1+8” administrative units, including Shanghai, Wuxi, Changzhou, Suzhou, Nantong, Ningbo, Huzhou, Jiaxing, and Zhoushan. With a diverse population and a relatively high degree of aging, the region experiences frequent inter-regional transportation connections. Township elderly populations also exhibit notable travel demands, making the study of their travel characteristics crucial for promoting urban-rural integration.

This study takes the Shanghai Metropolitan Area as the research region and divides the nine cities into 913 sub-city administrative units at the subdistrict (township) level. Based on the “Statistical Compilation Rules for Administrative Division Codes and Urban-Rural Division Codes”

(index no. 410A03-1201-201708-0006) from the National Bureau of Statistics of China, each subdistrict or township is classified according to the first digit of its urban-rural division code: 1 for urban and 2 for rural. In total, 404 urban subdistricts and 495 rural townships were identified (Figure 1).

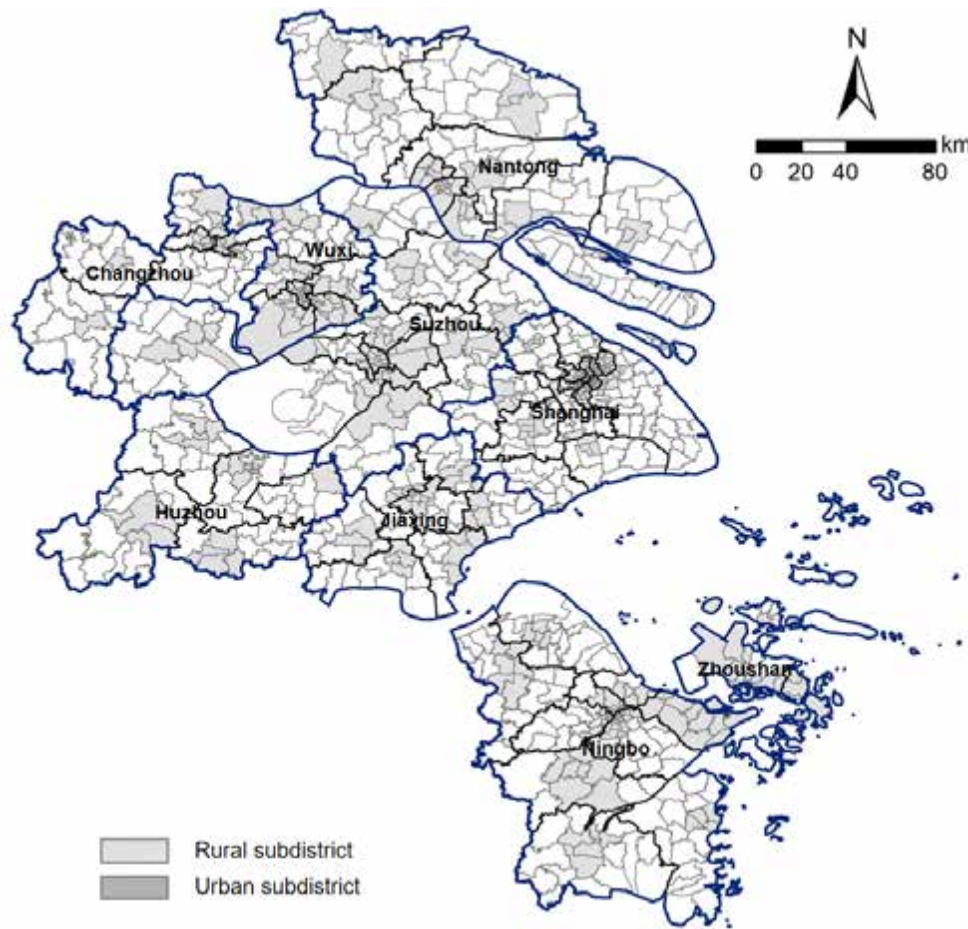


Figure 1. Location and urban-rural classification layouts of Shanghai metropolitan area

The primary data sources for this study include mobile signaling data and POI (Point of Interest) data. The mobile signaling data is derived from travel OD (origin-destination) data from October 2022, using base station grids to locate users' movements. The dataset captures trips for all purposes. By combining POI locations with dwell time, the purposes of trips are inferred to better understand the travel patterns of the elderly population in townships within the Shanghai Metropolitan Area.

Unlike traditional static data analysis, this study adopts a regional spatial network perspective to analyze the travel behaviors of elderly people between urban areas and townships, as well as between different townships. First, a population mobility network within the Shanghai Metropolitan Area is constructed using big data on population movements. The study explores the travel characteristics of elderly individuals through two layers: urban-rural and rural-rural mobility networks, thereby examining interconnections from a broader urban-rural perspective. Second, a statistical analysis is conducted on the travel destinations of elderly individuals for both urban-town and town-town trips. Finally, the study summarizes elderly travel characteristics and preferences by integrating survey data and other contextual information.

4. Results and discussion

4.1 The characteristics of urban-rural travel for the elderly in towns

Using mobile signaling data, this study extracts travel information of the elderly population and constructs urban-rural and rural-rural travel OD (origin-destination) networks. Due to age-related limitations, the number of elderly mobile phone users is relatively small, resulting in a lower overall volume of travel connections. However, observable patterns of elderly travel connectivity still emerge.

In the urban-rural travel network, high-intensity connections are mainly concentrated in Suzhou, showing a multi-centered structure. Although Shanghai exhibits tighter internal linkages between districts, the overall volume of connections is lower. This difference is directly related to the population composition of the two cities—Shanghai has a higher proportion of young people due to its more prominent emerging industries, whereas Suzhou's central districts have a higher proportion of elderly residents, resulting in stronger urban-rural travel connections among the elderly. In other cities within the metropolitan area, elderly urban-rural connections in townships are weaker and more pronounced in peripheral areas. Elderly individuals in townships mainly form direct connections with their regional urban centers, and travel distances are somewhat constrained. Only elderly residents in townships near city centers show relatively frequent travel. In the outer townships of each region, the elderly population generally has little direct interaction with urban districts, which is closely tied to differences in local economic industries and transportation accessibility.

Additionally, there are few cross-jurisdictional travel connections. Only limited intercity linkages are observed between Shanghai and Suzhou, while elderly mobility in other areas remains largely confined within municipal boundaries, typically within district or county-level jurisdictions. Some cross-district or cross-county elderly travel occurs within cities such as Wuxi, Changzhou, and Ningbo.

In the rural-rural travel network, elderly mobility demonstrates a more distinct networked structure. Centered around Suzhou and Shanghai, there is more frequent movement of elderly individuals between townships. Furthermore, elderly cross-border activities between townships are more evident, indicating that inter-township linkages are less constrained by administrative boundaries. In peripheral areas, elderly movement between townships is more frequent than between townships and cities, with elderly individuals tending to travel within nearby townships. (Figure 2)

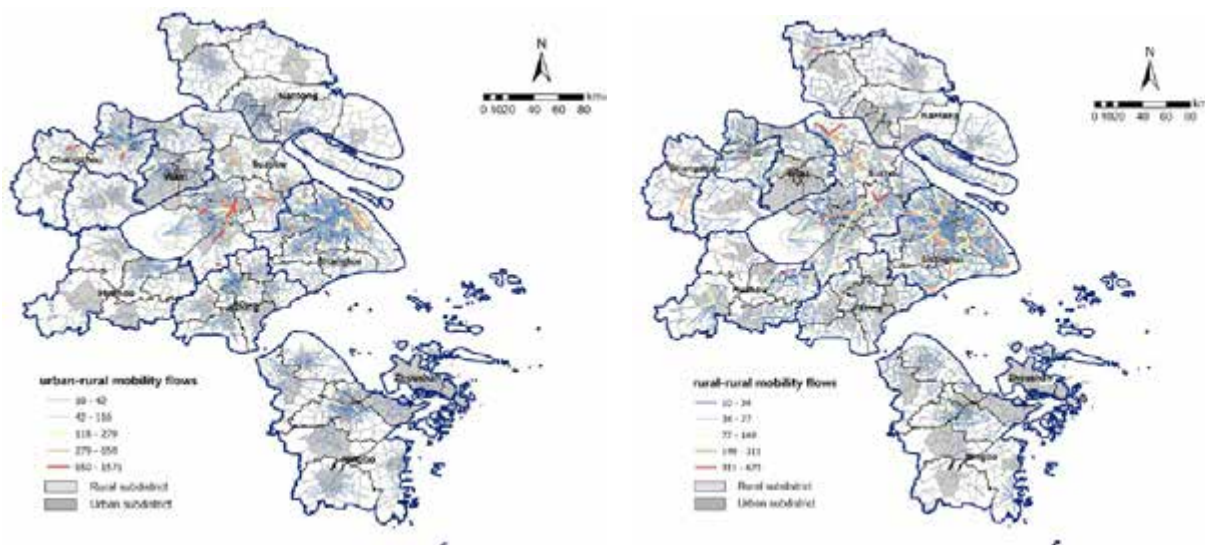


Figure 2. Characteristics of urban - rural elderly population flow network in towns of Shanghai metropolitan area

Overall, both urban-rural and rural-rural elderly travel connections are strongly influenced by distance and administrative boundaries. These constraints are closely related to elderly travel preferences, as most elderly travel in townships occurs within the local area—primarily driven by needs such as family visits, social interactions, and shopping. In contrast, intercity or cross-regional travel is less common, though certain groups—such as those with specific medical needs or those with children living in urban centers—exhibit higher frequencies of long-distance travel.

4.2 The characteristics of urban-rural travel purpose for the elderly in towns

The destinations of elderly travelers were extracted and analyzed separately for urban-rural and rural-rural travel patterns, revealing distinct differences between the two types of mobility.

For elderly individuals traveling between urban and rural areas, a significant portion have specific medical needs or children living in urban districts. Although these elderly residents live in townships, they often travel to urban centers for family visits or medical checkups, indicating that social needs and the availability of public services have a direct impact on their travel behavior. Additionally, shopping and leisure activities account for a relatively high proportion of urban-rural travel. This is largely because urban areas offer a wider range of public services and cultural facilities, attracting elderly township residents to engage in recreational activities. In contrast, travel purposes such as grocery shopping, running errands, child care, and work account for a smaller share of urban-rural travel. These types of travel are more common among elderly residents of townships that are geographically closer to urban centers and are more sensitive to distance and transport accessibility.

For elderly individuals traveling between townships, their travel purposes are closely related to the functions of the respective townships. Firstly, daily shopping accounts for a higher proportion of such travel. These trips typically involve going to central towns to purchase daily necessities such as food and household items, addressing basic everyday needs. Compared to urban-rural travel, the proportions of travel for purposes such as child care and participation in educational or community activities for the elderly are relatively higher, reflecting a preference for frequent, short-distance daily activities. On the other hand, the shares of travel for shopping, leisure, and medical purposes are lower in rural-rural contexts, likely due to smaller differences in service facilities between townships, which leads to reduced demand for such activities.

Moreover, visits to relatives and friends are also less common in rural-rural travel, suggesting that this type of travel is more often driven by the presence of children in urban areas. This pattern is closely related to China's urbanization process, wherein many young and middle-aged township residents have relocated to urban areas for work, prompting elderly family members to travel between rural and urban areas. Finally, since most elderly individuals are already retired, commuting for work is uncommon, with low proportions observed in both urban-rural and rural-rural travel. (Figure 3)

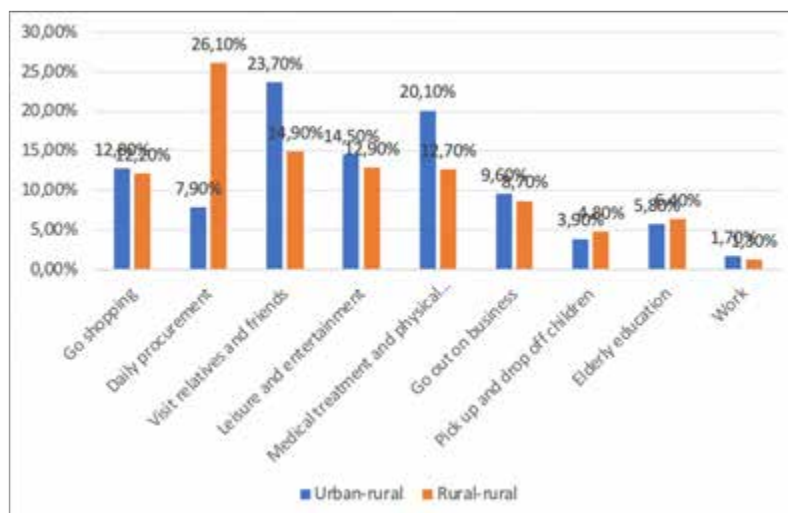


Figure 3. Characteristics of urban-rural travel purposes for the elderly in the Shanghai metropolitan area

4.3 Travel characteristics of the elderly based on traffic surveys

Based on the analysis of mobile signaling big data, this study incorporates survey data on the travel behavior of the elderly population in township areas of Shanghai. It statistically analyzes travel purposes, frequency, and timing across different age groups of elderly individuals. These travel behaviors are significantly influenced by factors such as physical health conditions and exhibit clear patterns and regularities.

4.3.1 Travel purpose

Shopping is the most fundamental travel activity for the elderly, accounting for over 35% of total trips and remaining above 33% across all age groups. The younger elderly group (ages 60–65) has a higher proportion of shopping-related travel. Leisure, entertainment, and cultural activities constitute a relatively stable share of travel across age groups, generally maintaining around 10%.

Due to increased health awareness and rising demand for medical services, doctor visits and health check-ups have become a significant travel purpose for the elderly, accounting for over 10% of trips. As age increases and physical function declines, the proportion of travel for medical reasons rises significantly—from 8% in the 60–64 age group to 35.7% among those aged 80 and above.

In contrast, travel for visiting family and friends, handling personal or household affairs, escorting others, and work-related purposes tends to decrease with age. (Figure 4)

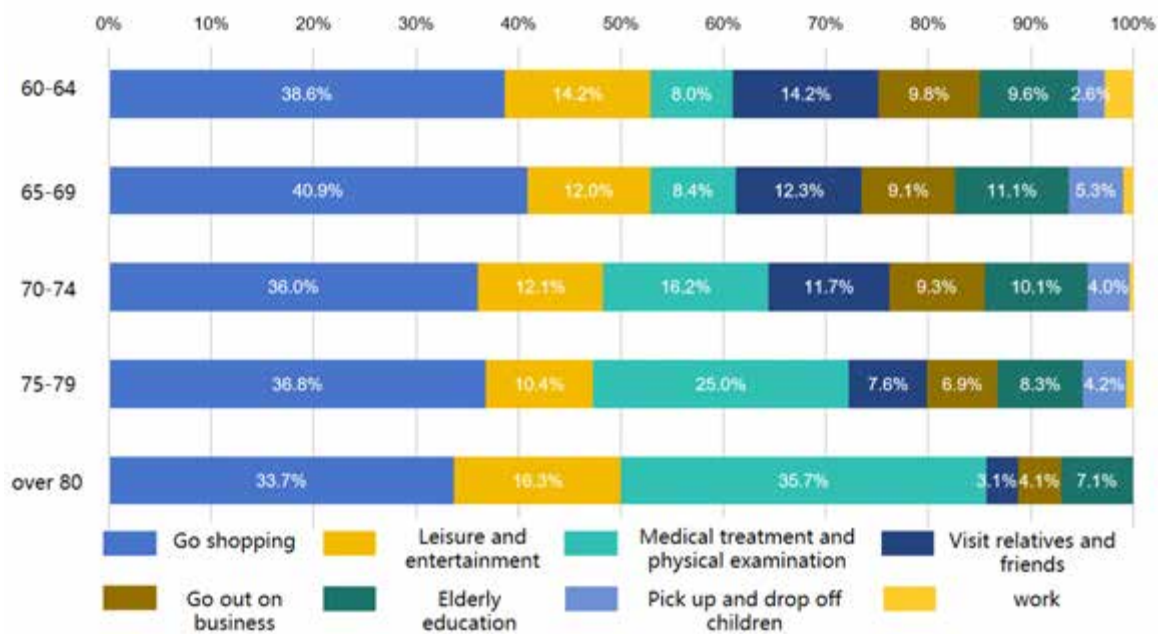


Figure 4. The travel purposes of the elderly of different age groups

4.3.2 Travel frequency

Elderly travel frequency is highly correlated with age. Survey results indicate that travel frequency decreases significantly as age increases: elderly individuals aged 60–62 make an average of 2.27 trips per person per day, while those aged 83 and above make only 0.77 trips per person per day.

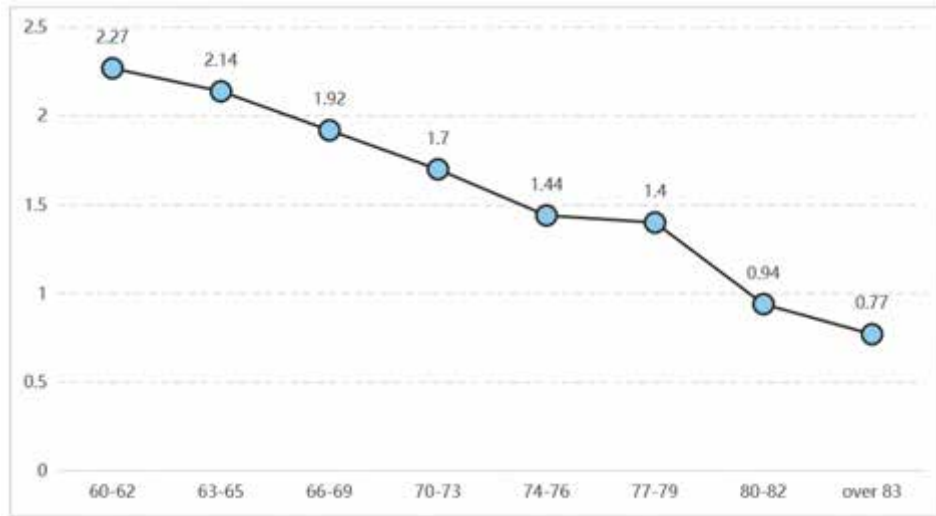


Figure 5. The travel frequency of the elderly of different age groups

From a frequency perspective, the travel level of the 60-65 age group (2.27 trips/day/person) is close to that of residents in central Shanghai (2.37 trips/day/person), suggesting that this age group represents a key transitional phase from working life to retirement. After age 66, travel frequency gradually declines, particularly after age 80, when physical deterioration becomes more pronounced and average travel frequency generally falls below 1.0 trip per person per day.(Figure 5)

4.3.3 Travel time

Cross-analysis results show that there is no significant correlation between travel time and age among the elderly. The distribution of travel times across different age groups is generally consistent, displaying two distinct peak periods: 7:00-9:00 a.m. and 1:00-2:00 p.m., with the morning peak showing significantly higher travel volume than the afternoon.

This pattern reflects the elderly's relatively abundant and flexible time management capacity. Their travel activities are more driven by daily habits and personal needs rather than by changes in age. It also indicates that, in post-retirement life, elderly individuals are able to choose more comfortable travel times that avoid congestion, resulting in regular but non-compulsory peak travel behaviors.(Figure 6)

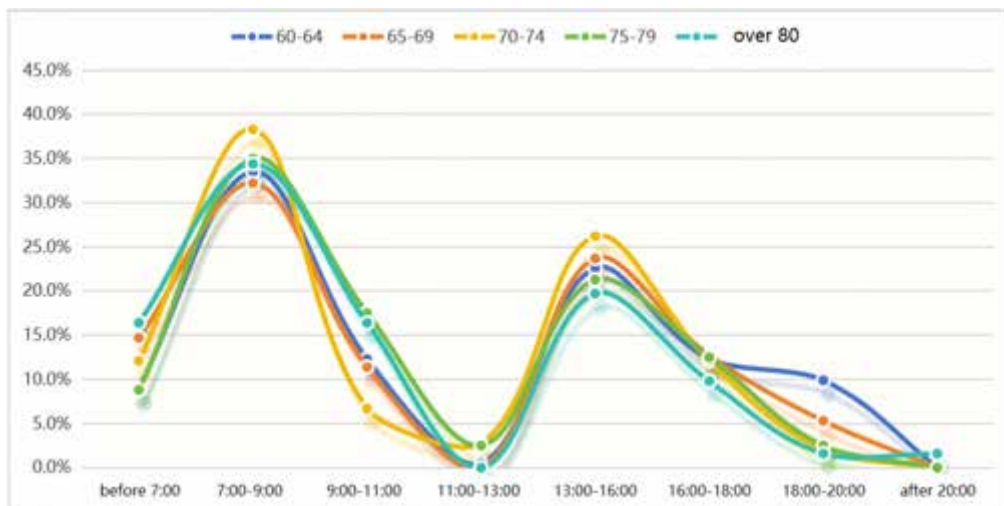


Figure 6. The travel time characteristics of the elderly of different age groups

4.4 Influencing factors of travel for the elderly in towns

Combining the previous data analysis and travel surveys, the travel characteristics of elderly residents in townships are influenced by multiple factors, primarily dominated by physical health and age stage, and constrained by geographic distance, transportation infrastructure, family structure distribution, and administrative boundaries. Among these, health needs, distribution of relatives, and availability of service resources are the core drivers for non-routine cross-regional travel by the elderly, while proximity-based daily life needs still dominate their everyday travel behavior.

First, individual characteristics play a role: physical decline due to aging directly affects travel frequency, travel time, and mode choice. After retirement, elderly people's travel purposes shift from "survival-oriented" to "life-oriented" activities (such as shopping and leisure), with a reduction in travel range, frequency, and duration. Health status and medical needs also have a direct impact, as medical visits and checkups become major travel purposes for the oldest age groups.

Second, spatial and geographic factors are influential. Whether urban-to-rural or rural-to-rural travel, trips tend to be limited to short distances and localized areas. Especially for elderly residents in peripheral townships, connections to urban core areas are weak, and activities tend to revolve around their immediate surroundings. The urban-rural spatial structure difference means urban centers—with their dense resources—attract more township elderly for medical visits, shopping, and family visits; meanwhile, township-to-township travel is more oriented toward daily needs like shopping and caregiving, with smaller service facility disparities leading to weaker incentives for cross-township trips. Both urban-rural and rural-rural elderly population flows are largely confined within municipal and district/county boundaries, with relatively few cross-administrative boundary connections, reflecting the continuing barrier effect of administrative borders on travel behavior.

Third, transportation and service facility distribution matter. The proportion of high-age elderly using public transit declines due to fixed routes, boarding difficulties, and balance issues, limiting their willingness to use buses. Township transportation infrastructure is relatively weak, making walking the primary mode; rigid needs such as medical visits often rely on taxis or private cars. Currently, elderly self-driving rates are low, but with generational shifts and improvements in transportation systems, township elderly driving rates may increase in the future, which could in turn affect travel frequency and range.

Fourth, social relationships and family structure influence travel motivations. The residential distribution of relatives affects travel purposes; urban-rural family visits are closely related to children's places of residence. Family structure and intergenerational residential separation are important drivers of elderly cross-regional travel. Daily caregiving responsibilities, such as picking up grandchildren and managing household chores, increase travel frequency within townships, especially among those aged 60 to 70.

5. Conclusions

The travel behavior of elderly residents in townships is characterized by "short-distance, life-oriented, and high dependency," influenced by multiple factors including age-related physical capacity, service resources, transportation infrastructure, and spatial structure. Elderly travel is not only a transportation issue but also an important reflection of eldercare services, urban-rural integration, and social equity. The travel needs of township elderly should be incorporated into long-term strategies for urban-rural integration and the equalization of public services. Through a combination of "soft and hard" measures, a low-cost, highly accessible, continuously serviced, and user-friendly travel system should be built. This paper proposes the following planning and policy recommendations focusing on transportation facilities, service layout, travel support, and spatial coordination:

1. Improve Elderly-Friendly Transportation Facilities System: Optimize non-motorized transport systems and enhance the age-appropriateness of public transit services. Improve bus route coverage to address shortcomings in inter-urban and rural transit, and increase medium- and short-distance shuttle lines between core towns and townships. Promote "customized bus" services by piloting appointment-based travel services for the elderly, meeting high-frequency demands such as medical visits and shopping.

2. Strengthen Balanced Layout of Public Service Resources Between Urban and Rural Areas and Townships: Address gaps in basic township-level services and enhance medical, shopping, and cultural facilities in central towns to meet elderly residents' daily needs for shopping, entertainment, and medical care, thereby reducing pressure for cross-district travel. Allocate medical resources reasonably and establish grassroots medical outreach for the elderly, especially in remote townships, promoting "village doctors at home" services to reduce travel for medical care among the oldest elderly. Enrich local activity spaces for the elderly by establishing senior centers, cultural halls, and other venues in townships to foster localized social and recreational environments.

3. Promote Diversified Travel Support Policies for the Elderly: Expand age-friendly transportation subsidies, especially for elderly individuals with high cross-district travel frequency between urban and rural areas (such as those regularly seeking medical care), to alleviate economic burdens. Establish a dynamic elderly travel data monitoring system that integrates mobile signaling data, transportation surveys, and community feedback to identify demand hotspots and weak points dynamically, supporting infrastructure optimization. Encourage volunteers or social workers to assist elderly persons during frequent and essential trips (e.g., medical visits, errands), improving travel safety and comfort.

4. Promote Cross-Administrative Regional Coordination and Resource Sharing: Strengthen regional collaborative transportation planning and establish mechanisms for elderly cross-city travel coordination in highly integrated areas. Optimize the allocation of cross-boundary public service resources, especially in regions where elderly residents frequently travel to other cities for medical care (e.g., elderly residents from Suzhou seeking treatment in Shanghai). Facilitate medical insurance recognition across cities, dedicated direct transit lines, and service linkage mechanisms.

References

Liu, Z. and Wang, X. (2021) Study on the Transition of Fertility and Influences in 1949-2019, *Northwest Population Journal*, 42(01), pp. 107-116.

Qi, P. (2019) On the Perfection of Rural Old-age Service System, *Northwest Population Journal*, 40(06), pp. 114-124.

Zhang, Z. et al. (2007) Analysis of travel characteristics of elders in Beijing, *Journal of transportation systems engineering and information technology*, 7(6), pp. 11-20.

Hu, X., Wang, J. and Wang, L. (2013) Understanding the travel behavior of elderly people in the developing country: a case study of Changchun, China, *Procedia-Social and Behavioral Sciences*, 96, pp. 873-880.

Zhang, Y. et al. (2019) Analysis of elderly people's travel behaviours during the morning peak hours in the context of the free bus programme in Beijing, China, *Journal of Transport Geography*, 76, pp. 191-199.

Mackett R. (2014) Has the policy of concessionary bus travel for older people in Britain been successful?, *Case Studies on Transport Policy*, 2(2), pp. 81-88.

[Wang, Y. et al. \(2023\) Mesoscale Structure in Urban-Rural Mobility Networks in the Pearl River Delta Area: A Weighted Stochastic Block Modeling Analysis, *ISPRS International Journal of Geo-Information*, 12\(5\), pp. 183.](#)

Xie, Z., Zhen, F. and Xi, G. (2022) Spatial Structure of Nanjing Metropolitan Area: The Perspective of Daily Commuting Flow, *Urban Planning Forum*, (05), pp. 90-98.

Wang, D. and Xue, G. (2016) Research on the urban capital factor productivity under the framework of TFP, *China Population, Resources and Environment*, 26(11), pp. 53-61.

Wang, Y. et al. (2022) The Characteristic of Population Flow and Spatial Governance Strategy of Suzhou-Wuxi-Changzhou Metropolitan Area, *Planners*, (6), pp. 27-33.