

Article

Does Intra-Urban Residential Relocation Affect the Elderly's Health and Well-Being? An Empirical Study of Nanjing, China

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Abstract: There are few existing studies from a spatial perspective that explore the mechanism of the living environment, relocated direction and relocated distance on the elderly's physical and mental health. Based on the 2019 household survey questionnaire data, this study utilizes a binomial logistic regression model and residents' in-depth interviews to study relocated behavior in Nanjing. We analyzed the spatial-temporal characteristics of relocated behaviors, the accumulation effect at different stages and the influence of relocated intention on physical and mental health among the elderly. The findings are as follows: (1) The mode of relocation among the elderly includes long-term cumulative effects and short-term effects. Frequent relocation has a cumulative negative impact on the physical and mental health of the elderly. (2) The elderly relocated in the short-term had a great negative impact on their mental health but had no significant impact on their physical health. (3) In the last relocation, active relocation had a significantly positive impact on physical health. The "centrifugal relocation" from the main urban area to the surrounding new cities has a significant positive impact on mental health. Moreover, long-distance relocations adversely affected mental health.

Keywords: binomial logistic regression; residential relocation; physical health; well-being; Nanjing



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1. Introduction

Relocation, or intra-urban residential relocation, is the housing adjustment process carried out by residents due to the mismatch between housing supply and demand [1]. Relocation is one of the important driving forces for urban spatial reconstruction [2]. Intra-urban residential relocation is an important factor that affects the evolution of urban morphology [2]. Residents move and regroup within the city, indirectly changing the urban spatial patterns [3]. Existing research divided relocation behavior into three aspects based on the process of relocation: the motivation, the process and the impact of residential migration [4], as shown in Figure 1.

Many experts in the field of urban science deeply explore the internal relationship between relocation and residents' daily lives from the perspective of residents [5]. It mainly includes four aspects. The first is how the researchers have conducted in-depth research on the transport travel mode of residents, including a low-carbon travel mode, transport travel choice, shopping, leisure travel mode, etc. [6]. The second is the perspective of the relationship between commuting behavior and built environment, such as the relationship between work and residence, and the correlation between commuting behavior and social networks [7]. The third is the indirect impact of residents' social attributes on their health,

including social differentiation, neighborhood environmental characteristics, urban built environments and residents' health relations [8,9]. The last is the relationship between residents' subjective psychological perception and health, including the subjective well-being of migrants, the elderly mortality and incidence rate, adolescent problem behaviors and the correlation between residents' physical and mental health [10].

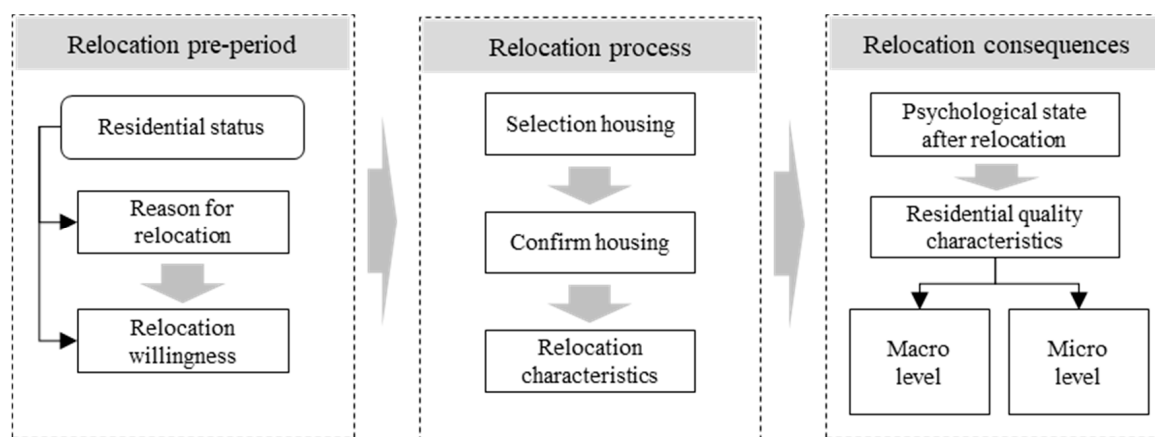


Figure 1. The regulatory and influencing factors on relocation behavior.

Relocation has been found to have an impact on the urban spatial structure, thereby affecting the residents' health [11]. The changes in urban spatial structure will change the key areas of urban development, leading to the phenomenon of urban spatial differentiation [12]. The differentiation of living space leads to the differentiation of individual socioeconomic status, neighborhood physical environment and social environment, which has indirectly effect on health [13,14]. The social environment in the neighborhood has a particularly important impact on health, especially in terms of "perception or satisfaction with the living environment" and "accessibility of social network resources" [15]. Relocation is an important factor that leads to the differentiation of urban social spatial structure and changes in individual behavior. Research can reflect the health impact of urban spatial structure differentiation by measuring the impact of relocation on health [16]. The relevant research originated from the behavior that a large number of the elderly moved to a community containing public medical resource gathering under the background of "deinstitutionalisation". Existing studies have primarily focused on the following. The first is the impact of relocation on mortality, incidence rate and physical and mental health indicators [17]. The findings show that relocation has short- and long-term cumulative effects on the elderly's health, but the impact mode is still unclear [18]. Some studies have found that relocation may lead to weight loss among the elderly, decreased mobility and negative psychological emotions [19,20]. Frequent relocation experiences may result in mental illness and out-of-going behavior disorders in the elderly [21,22]. However, if the elderly move to an area with better-built environment conditions, it may result in a stronger sense of happiness [23]. The second factor is the adjustment factor of the relocation's influence on health. The effect of relocation on health is affected by many factors, such as individual socio-economic attributes, social support, neighborhood relations and living habits [24–27]. This type of research mainly analyzes the regulatory effects of various variables through quantitative models, compares the differences between the groups affected and summarizes the mechanism of relocation on residents' health.

With the development of relevant theories of social psychology, some scholars began to study the impact of migration behavior on the subjective well-being of elderly individuals, and then expanded to the physical and mental health of the whole age group [28–30]. Some theoretical models provide a research framework for studying the health effects of residential relocation, including social capital theory and social ecology theory. Social capital theory refers to the social interpersonal relationships and social networks established within

the social ecosystem [28]. The social system constructed by relatives, important friends and neighbors in residential communities is an important social support environment for individuals. Social capital has a crucial impact on an individual's development goals, cognitive abilities and social interaction abilities. Some studies suggest that residential migration can disrupt this individual social network and cause social dysfunction [29]. Social capital is closely related to the relationships between individuals within and outside the family, while residential migration weakens the relationships within the family, between families and between neighbors, thereby affecting residents' mental health and subjective well-being [30]. Social ecological theory is a theory that studies the relationship between humans and various social environmental factors [31]. When studying health levels and health behaviors, social ecology theory requires analyzing relevant phenomena from the perspective of the interaction between humans and the environment [31]. Healthy behavior is an element within a complex system of people and the environment. The other elements within the system include: (1) internal factors, such as knowledge, attitude, behavior, self-concept and skills; (2) interpersonal relationships, social networks and support systems, such as family members, friends and colleagues; (3) group factors, including formal and informal social groups; (4) community factors, including the environment and related work conditions of the community; and (5) public policies, including various relevant laws and policies [32]. Scholars believe that the relocation behavior that affects health includes several important factors such as controllability, personal socio-economic attributes, important events in life processes and relocation willingness [32], as shown in Figure 2.

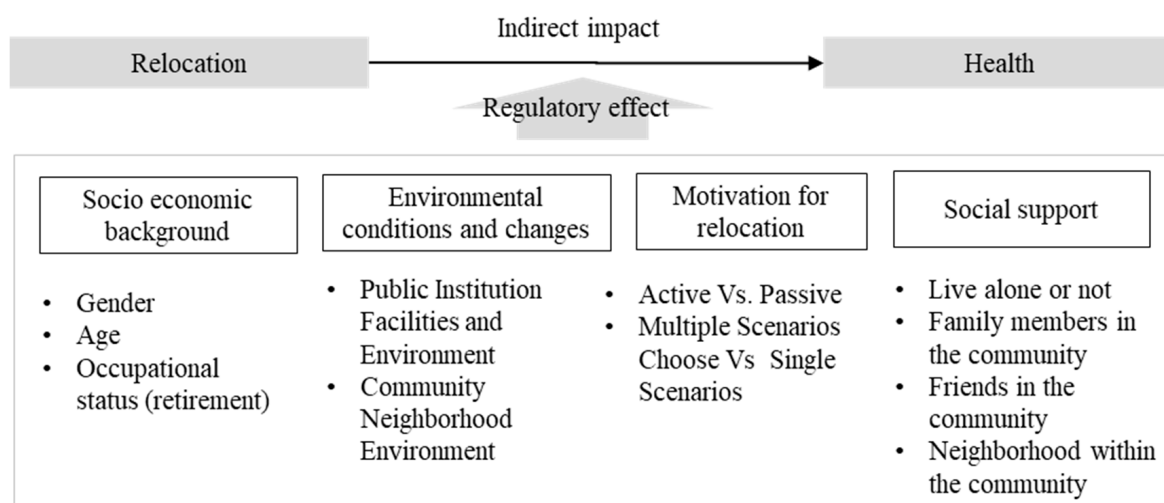


Figure 2. The stages and specific factors that affect the relationship between relocation and health.

Most of the existing research focuses on the field of medicine and psychology, targeting relocation behavior as a result [33]. The existing research lacks an in-depth analysis of the spatiotemporal characteristics and specific processes of relocation behavior [34]. Sociology refers to environmental variables related to health as contextual variables [35]. The different transportation environments in which residents live determine different situational variables and environmental experiences, thereby affecting their health [35]. Therefore, the perspective of temporal and spatial behavior is a new research trend in health geography [36]. Scholars have classified residents' daily activities into long-term behaviors such as employment and residential migration and short-term behaviors such as commuting and shopping. Relevant research should classify daily activities based on cyclical characteristics [37]. Relocation, as a long-term behavior of residents' daily activities, determines environmental variables closely related to residents' health [38]. Therefore, it is necessary to study the health effects of relocation from the perspective of spatiotemporal characteristics and explore the role and mechanism of the spatiotemporal characteristics of relocation in the influencing factors of residents' health. Furthermore, the existing research

lacks a comparative analysis of the residents' health before and after relocation and focuses on the changes in objective variables such as whether residents move and the relocation frequency. In terms of health effects, existing studies have mainly used the stress and coping theory and the moving to opportunity perspective for reference to deeply analyze the indirect impact of environmental changes on residents' physical and mental health [39]. Existing studies have given more attention to changes in residents' health indicators and less attention to the systematic impact mechanism of residents' relocation behavior patterns on health [40]. Moreover, the social capital theory posits that changes in social networks harm residents' mental health [41,42].

Currently, China is now in a stage of rapid urbanization and population ageing. In 2019, the urban population of China was 914.25 million, an increase of approximately 200 million compared to 10 years ago. The urbanization rate of the permanent population has increased from 37.6% to 63.5%. According to United Nations standards, when the elderly aged 65 and above account for 7% of the total population, the region can be considered as entering an aging society [43]. In 2019, the number of elderly people aged 65 and above in China reached over 200 million, accounting for 14.2% of the total population. China has entered a stage of deep aging society. The relocation activities of residents in large cities in China occur frequently, and most of them occur in urban built-up areas [44]. This study selected Nanjing, China, as a case study, analyzed the temporal and spatial characteristics of residents' relocation activities and explored the cumulative and short-term effects of relocation behavior and residents' health. We obtained residents' behavior data based on a questionnaire survey, and quantitatively measure residents' relocation from three aspects: migration frequency, migration period and migration characteristics. The overall research framework is shown in Figure 3. Firstly, this article measures the long-term cumulative impact of elderly population relocation frequency indicators on residents' health levels. Secondly, this article measures the changes in the health level of the elderly population before and after their relocation in the short term. Thirdly, this article measures the impact mechanism of specific relocation on the health level of the elderly population from three aspects: subjective migration willingness, objective migration distance and objective migration direction. Specifically, this study quantitatively analyzed the impact of relocation distance, intention and direction on residents' physical and mental health. Factors such as individual socio-economic attributes, living habits, neighborhood environment and social support were included in the model as control variables to analyze the process mediation and indirect impact of socio-economic variables on relocation activities. Based on social ecology theory, this study analyzes the effect of relocation on individual health through a quantitative mathematical model. The research results can provide a useful reference for individual residential choices and urban community construction.

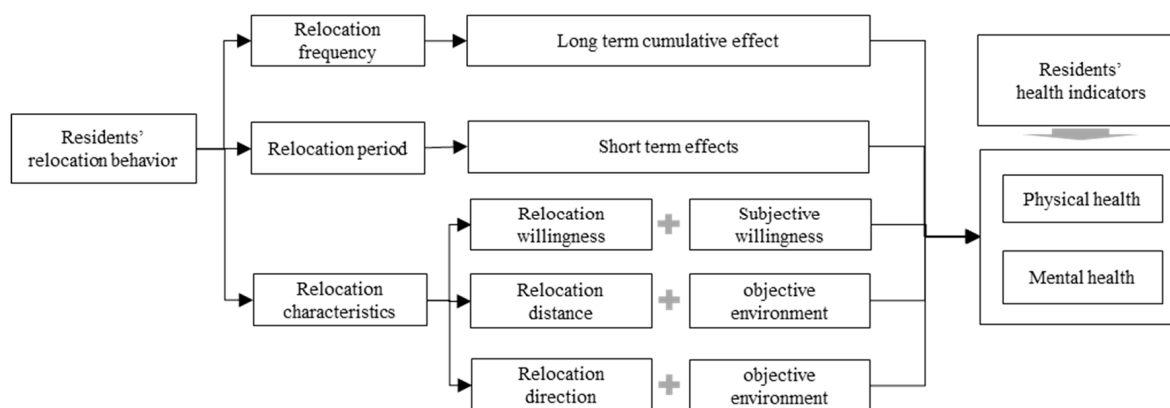


Figure 3. The overall framework of the relocation behavior effect on residents' health.

2. Data and Methods

2.1. Data Collection

Nanjing was selected for the case study. Nanjing is the capital city of Jiangsu Province, with a total land area of 6587.1 square kilometers and an urban built-up area of 868.3 square kilometers. In 2019, Nanjing had jurisdiction over 11 municipal districts, 94 streets and six towns. In 2019, the total population of Nanjing was 9.282 million, the urban population was 8.066 million and the urbanization rate reached 86.9%. The urban built-up area of Nanjing presents a “circle” spatial pattern. The inner old city covers an area of 172.3 square kilometers, including some streets in Gulou District, Qinhuai District, Xuanwu District and so on. The population distribution in the old urban area of Nanjing is dense, and the city is in the late stage of urbanization transformation and development. The main urban area around the old city covers an area of 372.8 square kilometers, including the Jianye District, Qixia District, Yuhuatai District and other streets. The outer new urban area covers an area of 323.2 square kilometers, including the Jiangbei New Area, Jiangning District and other streets.

This study selected the old urban area of Nanjing, the main urban area between the inner ring road and ring expressway and the area outside the ring expressway as the study area [45]. The study area included the Xuanwu, Qinhuai, Jianye, Gulou, Pukou, Qixia, Jiangning and Jiangning Districts. We select Nanjing as a representative case site, which includes two aspects. Firstly, the proportion of elderly people in Nanjing is relatively high. In 2019, there were 1.8246 million permanent elderly residents aged 60 and above in Nanjing, accounting for 19.36% of the total population [46]. Secondly, the relocation proportion of elderly people in Nanjing is relatively high. In the past 5 years, the demolition proportion of old communities in the main urban area of Nanjing has increased to 32.5%. The elderly population mainly lives in old communities in the main urban area. Due to large-scale demolition, the elderly need to choose a new residence place, leading to relocation behavior. Overall, 21 typical blocks were selected from eight administrative regions for the questionnaire survey (Figure 4). “Block” refers to a relatively independent land parcel with an area of about 1 square kilometer enclosed by surrounding roads. The blocks selected in this study included five types, namely historical blocks, unit communities, commercial housing blocks, affordable housing blocks and self-built houses (Table 1).

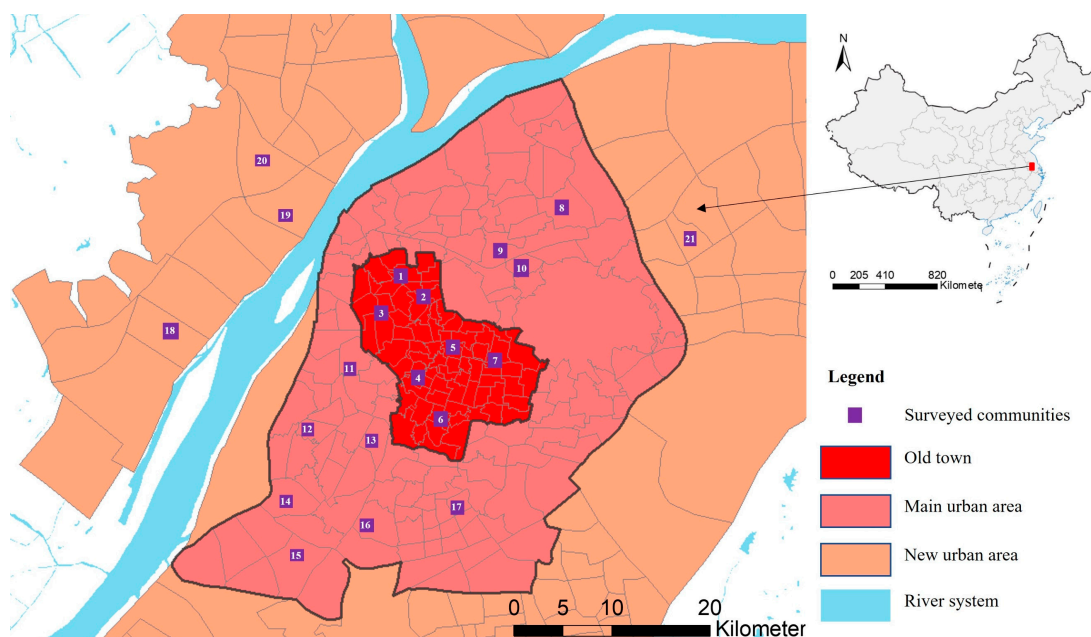


Figure 4. Distribution of the surveyed communities.

Table 1. Basic information of the investigated block.

	Block	Street	Main Information
Old Town	Xuanwumen block	Historic block	Residents built their own houses in the 1970s
	Suojincun block	Historic block	Residents built their own houses in the 1970s
	Maigaoqiao1 block	Historic block	Government buildings in the 1970s
	Meiyuanxincun block	Public housing block	Government buildings in the 1970s
	Honghua block	Public housing block	Residents built their own houses in the 1970s
	Honghulu block	Commercial housing block	New commercial housing built after 2000
Main urban area	Wulaocun block	Commercial housing block	New commercial housing built and resettlement housing after 2000
	Yueyahu block	Public housing block	Housing owned by government agencies
	Zhonghuamen block	Historic block	Residents built their own houses in the 1980s
	Guanghualu block	Indemnificatory housing block	Affordable housing after the 1980s
	Dingshan block	Indemnificatory housing block	Affordable housing after the 1980s
New urban area	Dachang block	Public Community	Housing owned by government agencies
	Xianlin block	Commercial housing block	New commercial housing built and resettlement housing after 2000
	Yanziji block	Commercial housing block	Commercial housing constructed after 2000
	Yaohua block	Commercial housing block	Commercial housing constructed after 2000

In January 2019, we conducted a questionnaire survey on the effects of relocation and the health of urban residents. According to the relevant provisions of the Chinese Law on the Protection of the Rights and Interests of the Elderly, the elderly generally refers to people over the age of 60 [43]. The elderly people we surveyed are permanent residents who have no major illnesses, are easy to move and are able to independently complete the questionnaire. We distributed a total of 1272 questionnaires and ultimately obtained 1063 valid questionnaires, with an effective response rate of 85.05%. The 1063 valid questionnaires have the proportion of men and women as 49.95:50.05.

The questionnaire passed the reliability test, with a coefficient α of 0.75 and acceptable reliability. From the basic situation of the elderly sample (Table 2), the proportion of unmarried and married samples was 21.73:78.27, with an average age of 62.05. The average monthly income of individuals is CNY 2000–4000. The majority of households have a population of three or less (55.16%). Approximately 78.2% of the populations have a self-rated health level of normal or above. The objective built environment element data include urban public service facility point of interest (POI) data, administrative boundaries at all levels of the city, etc. Among them, POI data are obtained through online maps, with attributes including the names, categories, longitudes and latitudes of various spatial entities. At the same time, we obtained the information about the residential location and daily activity trajectory of the elderly through a questionnaire survey and matched them in geographical space.

Table 2. Descriptive information on the sample of the elderly in the study (N = 1.063).

Item	Count	Proportion	Item	Count	Proportion	Item	Count	Proportion
Gender			Marital status			Self-rating physical mental status		
Male	531	49.95	unmarried	231	21.72	Very good	67	6.32
Female	532	50.05	married	832	78.27	Good	417	39.27
Age			Household Size			Normal	459	43.23
60–70	673	62.32	<3	586	55.16	Not good	120	11.18
71–80	247	23.24	3–5	359	33.77			
>80	143	14.44	>5	118	11.07			
Education level			Monthly individual income			Self-rating physical health status		
Primary school and below	379	35.69	<2000	183	17.18	Very good	120	11.37
Junior high school	518	48.71	2000–4000	652	61.30	Good	454	42.75
High school and above	166	15.61	>4000	228	21.49	Normal	272	25.63
						Not good	75	20.25

Note: The proportion unit is %.

We conducted a survey on the physical and mental health of residents in the questionnaire, as shown in Table 3. Among them, physical condition indicators include self-assessment of physical health index, frequency of physical discomfort and frequency of severe physical pain; mental health indicators include self-rated mental health index, frequency of self-rated low emotional state and self-rated level of life satisfaction. These questionnaire options can further refine and quantify the evaluation of residents' physical and mental health levels.

Table 3. Explanatory variables of residential relocation.

Analysis Dimension	Specific Indicators	Indicator Description
Cumulative effect	Relocation frequency	We took the frequency of the respondents' relocation after they settled in Nanjing as an explanatory variable. This variable expresses the cumulative effect of relocation behavior on residents' health.
Short-term effects	Relocation period	This indicator is utilized to determine whether the length of relocation has a differential impact on health status.
Relocation characteristics	Relocation Willingness	The indicators are divided into active relocation and passive relocation. We define Gulou District and Qinhuai District as the old urban area, and the peripheral areas include the main urban area and the new urban area.
	Relocation direction	We subdivide the relocation direction into four directions: interior–interior, interior–exterior, exterior–interior and interior–exterior. It has been pointed out that the orientation of relocation is related to the change in the living environment [47].
	Relocation distance	We make spatial matching for the residential areas before and after the relocation and further calculate the relocation distance. Long-distance relocation is generally considered to be related to social network faults and environmental change [48].

2.2. Indicator System

The relocation behavior studied in this paper mainly refers to intra-city relocation between streets in Nanjing, focusing on the supply of medical institutions and other public services around the elderly relocation site. Few studies have linked the spatial characteristics of relocation to health effects [32,35,40]. This paper presents a multi-dimensional analysis of the spatiotemporal characteristics of relocation, specifically relating the relocation direction, relocation distance and residents' health effects. The indicators of relocation were employed to measure the actual health effects and mechanisms. Based on the existing research findings, we believe that relocation can be measured from multiple dimensions, such as relocation frequency, duration, direction, distance and intention (Table 3). The frequency of relocation reflects the cumulative effect of relocation [49,50], and the length of residence after relocation signifies the short-term effect of relocation [51]. The willingness to relocate is also a crucial factor affecting residents' health [52]. These indicators are important explanatory variables for the impact of relocation on health.

The health measurement standards of the residents are listed in the following table (Table 4). Residents' physical health (self-rated physical health) and mental health (self-rated mental health) are the two main dimensions for measuring health. The World Health Organization believes that health refers to a good state of physical, psychological and social adaptation [48,52] and includes four aspects. The first is to be energetic, and residents can calmly cope with daily life and work. The second is emotional stability, positive attitude and maintaining optimism when facing difficulties. The third is to be good at rest and have good sleep quality. The fourth is that residents have a strong ability to cope with changes in the external environment. We measured the influence of relocation on the daily lives of the elderly through physiological and psychological indicators. Self-assessment of physical health is one of the most commonly employed indicators in residents' health research and is usually measured in the form of grading [53,54]. The physical discomfort index expresses a situation wherein residents' physical discomfort affects their work efficiency. The physical pain index expresses the frequency of physical pain in

residents within 1 month. Self-assessment of mental health mainly adopts the mental health assessment scale recognized by the World Health Organization (WHO) [55]. Psychological depression corresponds to physical discomfort, reflecting the negative emotions that affect residents' daily life and work status. Life satisfaction is also commonly used as a measure of mental health and is generally divided into six levels [54]. Depression is the most common psychological disorder, which refers to a continuous and long-term state of depression in patients [55]. People with depression have a low mood, unhappy life and prolonged depression. Patients may experience a decrease in self-evaluation, resulting in feelings of helplessness, hopelessness, helplessness and worthlessness. Patients often experience self-blame and self-guilt, and in severe cases, symptoms of delusions of guilt and hypochondriasis may occur [54]. Accordingly, this study classifies the mental health level into two categories and constructs a logistic regression analysis model. A value below 13 indicates poor mental health, whereas a value higher than 13 indicates good mental health. Moreover, life satisfaction is a critical indicator of residents' mental health [56], which is mainly divided into five grades.

Table 4. Measurement indicators of physical and mental health.

Indicators		Questions	Scoring Rules
Physical health	Physical Health Score	"Please evaluate your physical health"	1 = very poor; 2 = poor; 3 = average; 4 = good; 5 = very good
	Physical discomfort	"In the past month, did you feel unwell and found these problems affecting your work or other daily activities?"	1 = no; 2 = rarely; 3 = sometimes; 4 = often; 5 = always
	Severe pain	"Did you experience severe pain in the past month?"	1 = no; 2 = rarely; 3 = sometimes; 4 = often; 5 = always
Mental health	Mental Health Score	Item 1: "I feel happy"	The general Likert scale for mental health used by WHO was utilized for scoring [55]. There were five questions in total, and six items (0–5 points) represented the degree of agreement with the item description in the past two weeks; 0–25 points in total
		Item 2: "I feel calm and relaxed"	
		Item 3: "I feel energetic"	
		Item 4: "I feel my body recovered after I wake up"	
		Item 5: "My life is full of interesting things every day"	
	Emotional problems	"In the past month, did you feel depressed or anxious, and did these problems affect your work or other daily activities?"	1 = no; 2 = rarely; 3 = sometimes; 4 = often; 5 = always
	Life satisfaction	"Are you satisfied with your quality of life?"	1 = very dissatisfied; 2 = dissatisfied; 3 = average; 4 = relatively satisfied; 5 = very satisfied

2.3. Research Methods

In this study, the frequency, duration, distance, willingness and other indicators of relocation were employed as explanatory variables to measure the impact of relocation on residents' health. It has been considered that personal socio-economic attributes and personal living habits have an impact on residents' relocation and physical and mental health. Among them, social support mainly plays a role in mental health, whereas hardware facilities (e.g., medical support) are primarily involved in physical health [47,49,57]. Therefore, we used these measures as the control variables. SPSS 22.0 software was employed to measure the direction and intensity of the relocation effects on health. Logistic regression models are frequently utilized in epidemiological studies. Specifically, logistic regression analysis results included the following indicators: partial regression coefficient B, standard error (SE), Wald chi-square test value, *p*-value and odds ratio (OR) value ($\exp\beta$) and 95% confidence interval (CI) value of OR value. In the field of epidemiology and public health, the OR is usually used to measure the specific factors influencing health effects. The OR value refers to the ratio of the event occurrence rate to the non-occurrence rate. When the OR value is significant at a significance level of 0.05, the OR value is also used as a dose indicator. If $OR < 1$, this factor is negatively related to the health level and has a protective effect on disease prevention. If $OR > 1$, this factor is positively correlated with health levels [56,58]. Therefore, OR and 95% CI were the key indicators in the logistic

model. This indicator was employed to test the effect of the direction and intensity of the relocation process on health.

The effects of relocation on health can be accumulated and are related to residents' life stages. Relocation in different periods has different impacts on residents' health. To verify this cumulative effect, the residents' relocation experience was divided into three stages: nearly 1 year, nearly 3 years and nearly 5 years. Binomial logistic regression analysis is a multivariate analysis method used to study the relationship between relocation behavior and explanatory variables. This method is mostly utilized in medical sociology and public health research and can comprehensively test the factors influencing health risk [43]. Generally, there are two classification results of health prediction: healthy and unhealthy. The research assumptions in this study were consistent with the conditions of the binomial logistic model. The dependent variable Y of the model obeys a binomial distribution, and its binomial classification value is either 0 or 1. The overall probability of $Y = 1$ is $\pi(Y = 1)$ and the logistic regression model corresponding to m independent variables $x_1, x_2, \dots, x_m$ is as follows:

$$\pi(Y = 1) = \frac{\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 \dots + \beta_m x_m)}{1 + \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 \dots + \beta_m x_m)} = \frac{1}{1 + \exp[-(\beta_0 + \beta_1 x_1 + \beta_2 x_2 \dots + \beta_m x_m)]}$$

where, $x_1, x_2, \dots, x_m$ are the driving factors affecting health-related variables. β_0 is the intercept (or constant term) and β_j is the regression coefficient to be calculated corresponding to x_j ($j = 1, 2, \dots, m$). If the value is positive (negative), the relevant independent variable $x_{j,i}$ can increase (decrease) the occurrence rate of event i . The higher the absolute value of β_j , the greater the influence of the independent variable $x_{j,i}$ on the occurrence rate of event i . $\exp(\cdot)$ is an exponent based on the natural logarithm [42].

The fitting effect of the model was further evaluated. We used a sample of residents in good health as the reference group. The independent variables of the model were selected via the entry method. The model estimation results are presented in the following table (Table 5). Among them, pseudo R^2 values were 0.186 and 0.175, respectively, meeting the needs of social investigation. According to the Hosmer–Lemeshow test index, χ^2 of the model is 4.938 and 9.468, respectively, and the p values are 0.764 and 0.304, respectively. Therefore, we cannot reject the hypothesis of a good fit and the model results can be accepted. The accuracy rates for physical and mental health were 76.6% and 70.1%, respectively, highlighting that the fitting effect of the model was good.

Table 5. Fitting test of relocation cumulative effect model on health.

Model Summary	−2 Log-likelihood	Cox and Snell R^2	Nagelkerke R^2
Model I (physiological health)	1009.579	0.186	0.268
Model II (mental health)	1160.088a	0.175	0.239
Hosmer–Lemeshow test	χ^2	df	Significance
Model I (physiological health)	4.938	8	0.764
Model II (mental health)	9.468	8	0.304

3. Results

3.1. General Characteristics of Residents' Relocation and Health

3.1.1. Temporal and Spatial Characteristics of Relocation Activities

We performed statistics on the relocation frequency of residents in Nanjing, and the relocation frequency of most residents was 1–2 times. Residents who had moved more than once accounted for 75.7% of the total respondents. Specifically, this notion outlines that the resident changed his/her residence after entering Nanjing. The frequency of relocation of residents in Nanjing is generally increasing in terms of the characteristics of the different stages. After 2000, the relocation frequency increased significantly, with an annual relocation rate of 26.8%. In the 21st century, the average annual relocation rate of Nanjing residents was 35.6%. This value is generally consistent with the relocation rate of

urban residents at the same developmental stage reported in previous studies [57]. From the perspective of relocation distance, the spatial characteristics of the elderly in Nanjing conformed to the law of distance attenuation (Figure 5). Among them, the elderly within 5–10 km accounted for the highest frequency of relocation. The frequency of relocation within 10 km accounted for more than 60%, that above 20 km accounted for only 5.20% and that within 10–20 km accounted for 30.89%.

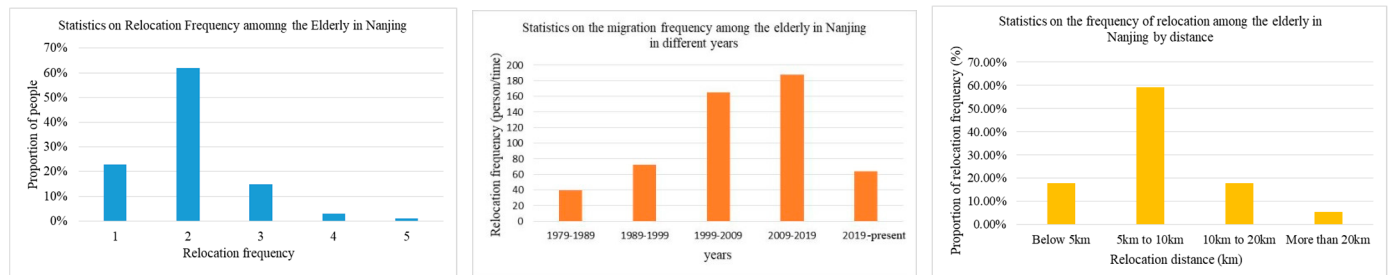


Figure 5. Statistics of Nanjing residents' relocation frequency (left), statistics of Nanjing residents' relocation frequency by time period (middle) and characteristics of Nanjing residents' relocation distance (right).

We collated and analyzed 1388 relocation samples from Nanjing and acquired 976 records of relocation activities. Thereafter, the spatial location of the residence before and after the relocation was connected, and the relocation path of the residents was obtained (Figure 6). In general, relocation mainly shows the “centrifugal” spatial characteristics of the old city to the new city. There are intensive short-distance relocation activities in the main urban area, whereas there are few short-distance relocation activities in the surrounding new urban area.

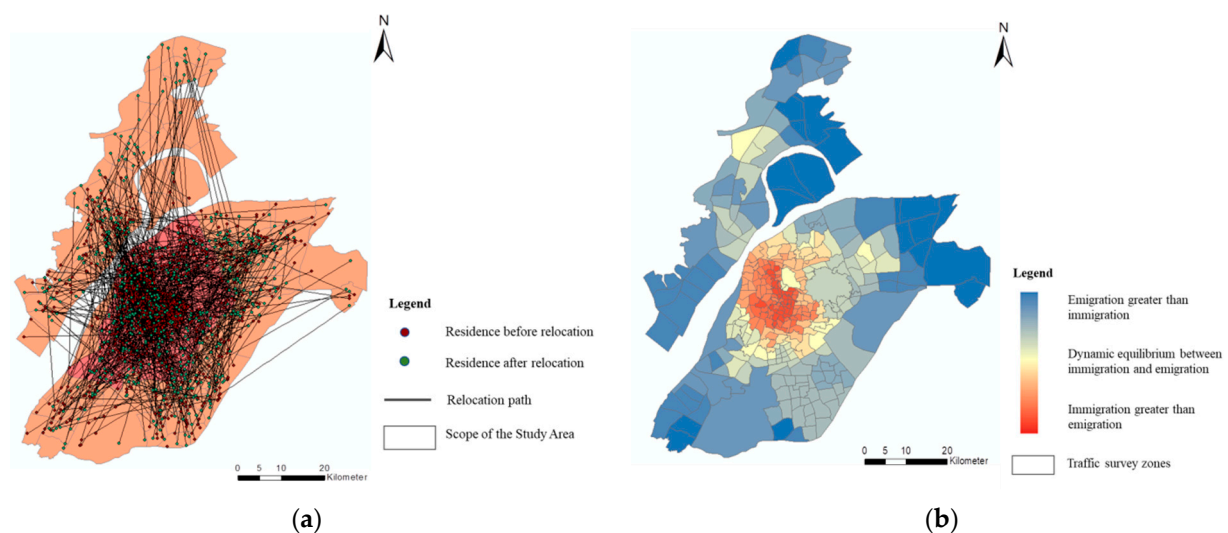


Figure 6. Relocation path (a) and quantity (b) among the elderly in Nanjing.

We defined the Jiangbei New Area and Jiangning District as new urban areas and defined other areas as main urban areas or old urban areas to obtain the characteristics of residents' relocation direction (Table 6). According to the statistics of administrative districts, the outcomes show that the distribution of residents' locations of relocation is relatively average, and the districts with more relocation are Pukou District, Jiangning District and Qixia District. The relocation areas of residents were mainly concentrated in the Jianye District (35.27%) and Gulou District (21.20%). From the perspective of the spatial pattern of relocation activities, the relocation rate from the peripheral area to the main urban area was relatively high (accounting for approximately 63.21%), while the proportion

of relocation from the main urban area was only 13.83%. Second, short-distance relocation in the old urban area accounted for 15.90%. The proportion of people moving from the old city to peripheral areas was the lowest, accounting for 9.38%. Gulou District accounts for 10.7% of the internal relocation activities in the main urban area, and the Jiangning and Qixia districts account for 7.14% and 6.32%, respectively.

Table 6. Statistics of the residents' imrelocation and erelocation places among the elderly in Nanjing.

Move In and Out	Xuanwu District	Qinhuai District	Jianye District	Gulou District	Pukou District	Qixia District	Jiangning District	Total	Old City	Peripheral Area
Xuanwu District	2.45%	1.43%	3.06%	/	1.22%	5.10%	1.33%	14.58%		
Qinhuai District	0.10%	0.31%	0.10%	/	/	0.51%	/	1.02%		
Jianye District	0.92%	2.24%	6.32%	/	0.51%	5.81%	2.96%	18.76%		
Gulou District	/	/	0.51%	/	0.20%	0.51%	0.10%	1.33%		
Pukou District	1.94%	2.65%	4.89%	/	3.77%	4.28%	3.36%	20.90%	/	/
Qixia District	0.51%	0.61%	2.34%	0.10%	1.43%	10.70%	1.53%	17.23%		
Jiangning District	2.14%	2.85%	3.87%	/	1.63%	8.26%	7.14%	25.89%		
Total	8.05%	10.09%	21.20%	0.10%	8.87%	35.27%	16.41%	100%		
Old city				/					15.90%	9.38%
Peripheral area				/					30.89%	43.83%

3.1.2. Health Characteristics of the Elderly Migrants

We conducted a cross-tabulation analysis between relocation attributes and the health status of the elderly (Table 7). According to the model results, when controlling for the influencing factors of individual socio-economic attributes, lifestyle habits and neighborhood social support on residents' health, the overall frequency of residential relocation has a negative impact on residents' physical and mental health. Overall, physical health is more affected by the cumulative effects of residential relocation than mental health. From the perspective of relocation frequency at different stages, residential relocation has both short-term and long-term cumulative effects, with varying degrees of impact at different stages. For the elderly population, the frequency of relocation within 5 years has a significant impact on both physical and mental health, and this impact mechanism has a typical short-term effect. This conclusion is similar to existing studies. As the elderly move to a new location, their inner anxiety gradually weakens with the extension of living time, and their mental health level continues to improve [43,44]. The findings showed that the elderly who moved more frequently within 5 years had worse physical health, and those who moved more frequently also had worse mental health. However, with the longer time interval of the elderly's relocation, their mental health showed a significant trend of improvement. Elderly people who moved actively had better physical and mental health than those who moved passively. Elderly individuals who moved across administrative regions had poorer mental health. However, due to the short relocation distance, the elderly living in the area are in relatively good physical health.

Table 7. Descriptive statistics of residential relocation and health among the elderly.

Relocation Attribute			Physical Health		Mental Health		Total Samples/Numbers
			Poor/%	Good/%	Poor/%	Good/%	
Relocation frequency	Number of relocations in 5 years	0 time	27.83	72.17	34.79	65.21	848
		1 time	26.32	73.68	45.61	54.39	171
		2 time	80.00	20.00	100.00	0.00	10
	Number of relocations in 3 years	0 time	25.67	74.33	37.32	62.68	822
		1 time	33.90	66.10	36.99	63.01	177
		2 time	60.00	40.00	40.32	59.68	30
	Number of relocations in 1 year	3 time	0.00	0.00	0.00	100.00	4
		0 time	25.67	74.33	38.20	61.80	822
		1 time	33.90	66.10	31.64	68.36	177
		2 time	60.00	40.00	43.33	56.67	30
Relocation interval	Interval period	Within 1 year	35.00	65.00	55.00	45.00	40
		2–3 years	23.77	76.23	50.00	50.00	122
		4–5 years	25.00	75.00	36.21	63.79	116
		More than 5 years	28.89	71.11	34.35	65.65	751

Table 7. Cont.

Relocation Attribute			Physical Health		Mental Health		Total Sam- ples/Numbers
			Poor/%	Good/%	Poor/%	Good/%	
Relocation characteristics	Relocation willingness	passive	40.43	59.57	50.00	50.00	94
		active	26.84	73.16	35.94	64.06	935
		No relocation	23.04	76.96	34.35	65.65	230
	Relocation direction	Inner City-Inner City	31.93	68.07	31.02	68.98	548
		Inner City-Outer City	25.96	74.04	36.54	63.46	104
		Outer City-Inner City	22.88	77.12	65.25	34.75	118
		Outer City-Outer City	24.14	75.86	65.52	34.48	29
	Average relocation distance		6.39/km	6.51/km	7.76/km	5.72/km	6.48/km

To exclude the possible collinearity correlation between physical health indicators and mental health indicators, we conducted a cross-tabulation test on these two attributes (Table 8). The sig value of Pearson's chi-square test was 0.012, which is less than 0.05. The results show that there are differences between residents' physical and mental health that need to be classified.

Table 8. Cross-analysis of residents' physical and mental health.

		Physical Health				Mental Health		Pearson's Chi-Square Test
		Poor/%	Good/%			Poor/%	Good/%	
Mental health	Poor	32.64	67.36	Physical health	Poor	43.25	56.75	0.012
	Good	25.39	74.61		Good	34.86	65.14	
Number of samples		289	740	Number of samples		289	740	

3.2. Cumulative Effect of Relocation Frequency on the Elderly's Health

Relocation may have a cumulative effect on health, which is related to the life stage of the elderly. With the continuous accumulation of relocation frequency, the effect of relocation on health gradually increases. In this study, the elderly's relocation frequency was divided into three periods: 1 year, 3 years and 5 years. The model takes relocation frequency as the dependent variable, sets the reference value of physical health and mental health as 1, and conducts a binomial logistic regression analysis. The validity of the model was verified, and the reliability of the results was acceptable (Table 9). This study's findings are consistent with existing studies, mainly as follows. First, frequent relocation within 5 years harms the physical health of the elderly, especially those who do not exercise regularly [42]. Second, frequent relocation within 5 years adversely affects the mental health of the elderly, which has a significant negative impact on the mental health of married elderly, thus leading to the generation of problem behaviors in the elderly [42,57]. Third, recent relocation is more likely to cause inadaptability pressure on the elderly, which will negatively impact their health [32]. Finally, frequent relocation had a significant impact on the mental health of elderly people with different incomes. This phenomenon may be related to the emphasis of the elderly on stable living conditions [55].

Table 9. Models of how relocation frequencies affect health (cumulative effect model).

Variable	Physical Health (Cox and Snell R ² = 0.184, Accuracy = 76.3%)				Mental Health (Cox and Snell R ² = 0.175, Accuracy = 70.1%)			
	Coef.	S.E.	95% CI		Coef.	S.E.	95% CI	
			Lower Limit	Upper Limit			Lower Limit	Upper Limit
Relocation frequency								
Within 5 years	−0.664 ***	0.515	0.345	0.769	−0.700 ***	0.496	0.345	0.714
Within 3 years	−0.037	0.964	0.735	1.264	−0.095	0.909	0.705	1.172
Within 1 year	−0.364 *	0.695	0.502	0.963	−0.080	0.923	0.671	1.270
Personal habits								
Smoking # Yes	−0.022	0.979	0.568	1.684	0.394	1.482	0.921	2.385
Drinking # Yes	−0.236	0.790	0.513	1.218	−0.067	0.935	0.641	1.365
Exercise # Yes	−0.636 ***	0.529	0.365	0.768	−0.216	0.805	0.578	1.123

Table 9. Cont.

Variable	Physical Health (Cox and Snell R ² = 0.184, Accuracy = 76.3%)				Mental Health (Cox and Snell R ² = 0.175, Accuracy = 70.1%)			
	Coef.	S.E.	95% CI		Coef.	S.E.	95% CI	
			Lower Limit	Upper Limit			Lower Limit	Upper Limit
Individual socio-economic attributes								
Gender # Female	−0.263	0.768	0.454	1.300	0.025	1.026	0.646	1.629
Age	−0.084 ***	0.919	0.905	0.934	−0.008	0.992	0.979	1.006
Marital status # unmarried								
Married	0.267	1.306	0.781	2.184	−0.583 **	0.472	0.010	0.736
Divorced or widowed	−1.452	0.234	0.012	4.754	0.752	0.263	0.014	1.009
Annual family income #More than 40,000								
Less than 10,000	−1.429	0.240	0.027	2.163	−2.465 *	0.085	0.015	1.140
10,000–20,000	−1.190	0.304	0.034	2.729	−2.142 *	0.117	0.026	8.701
20,000–40,000	−1.259	0.284	0.031	2.615	−2.050 *	0.129	0.015	4.688
Neighborhood and social support								
Number of relatives	−0.060	0.942	0.768	1.155	0.004	1.004	0.764	1.319
Neighborhood relations	−0.009	0.991	0.946	1.038	0.240 ***	1.271	1.213	1.332
Number of acquaintances	−	−	−	−	0.082	1.085	0.865	1.361
Density of medical facilities	0.071 **	1.074	1.023	1.128	−	−	−	−

Note: The dependent variable 1 refers to good health and 0 refers to poor health. # refers to reference variables (control group). − represents no parameter, which means that the variable is not in the model. * indicates 0.1 significance level, ** indicates 0.01 significance level and *** indicates a significance level of 0.005 or above.

3.3. The Effect of Short-Term Relocation Experience on the Elderly's Health

The elderly require an adaptation period after each move. This period has a negative impact on the physical and mental health of the elderly. The model tests the health effects of elderly people living in a new house for a long time. All independent variables related to relocation behavior were included in the health effect model, and the fitting effect was acceptable (Table 10). We control for relevant indicators, such as individual socio-economic attributes in the model, and find the following significant conclusions. First, compared with the elderly who have lived for more than 5 years, the probability of the elderly who have moved within 1 year to maintain health has decreased by 1.251 times. Within 2–3 years of relocation, the elderly's probability of maintaining mental health decreased by 1.074 times. With the continuous growth in the elderly's stay time, the impact of the adaptation period of relocation significantly decreased. Second, the length of relocation had a significant negative impact on male groups and the elderly who lack exercise. The short-term relocation experience has a significant negative impact on the mental health of the elderly. In particular, in terms of social neighborhood relations, short-term relocation experiences had a significant negative impact on the psychological health of the elderly. This outcome is similar to the conclusions of previous studies [43].

3.4. The Influence of Relocation Characteristics on the Elderly's Health

We further analyzed the influence of characteristics, such as relocation intention, direction, and distance on the elderly's health. In general, the influence of relocation characteristics on elderly health differed significantly. We included the relocation characteristics in the binomial logistic regression model, and the goodness of fit of the model reached a credible level (Table 11). The willingness to relocate has a significant impact on the elderly's physical health but has no significant impact on their mental health. Specifically, compared with the elderly who move actively, those who move passively are more likely to be physically unhealthy. Generally, the purpose of active relocation is to improve living conditions. A good living environment is conducive to the maintenance of physical and mental health among older adults. However, the relocation process consumes much of the physical strength of elderly people. Elderly people still need to adapt to the new environment after relocation; hence, these factors can harm the elderly both physically and mentally.

Table 10. Models of how relocation frequencies affect health (short-term effect model).

Variable	Physical Health (Cox and Snell R ² = 0.181, Accuracy = 75.2%)				Mental Health (Cox and Snell R ² = 0.171, Accuracy = 69.7%)			
	Coef.	S.E.	95% CI		Coef.	S.E.	95% CI	
			Lower Limit	Upper Limit			Lower Limit	Upper Limit
Move in period after relocation # 5 years or more								
Within 1 year	−1.250 ***	0.287	1.251	0.608	−1.074 ***	0.342	0.165	0.706
2–3 years	−0.216	0.805	0.486	1.334	−0.571 **	0.565	0.366	0.871
4–5 years	0.171	1.187	0.702	2.006	−0.015	0.985	0.625	1.554
Personal habits								
Smoking # Yes	−0.037	0.964	0.561	1.655	0.387	1.473	0.916	2.368
Drinking # Yes	−0.253	0.776	0.504	1.196	−0.087	0.916	0.628	1.337
Exercise # Yes	−0.624 ***	0.536	0.369	0.777	−0.195	0.823	0.590	1.147
Individual socio-economic attributes								
Gender # Female	−0.291	0.748	0.444	1.258	0.003	1.003	0.632	1.593
Age	−0.086 ***	0.917	0.903	0.932	−0.009	0.991	0.978	1.004
Marital status # unmarried								
Married	0.192	1.211	0.722	2.033	−0.666 ***	0.539	0.011	0.793
Divorced or widowed	−1.390	0.249	0.013	4.920	0.619	0.277	0.014	1.056
Annual family income # more than 40,000								
Less than 10,000	−1.465	0.231	0.025	2.155	−2.390 *	0.092	0.015	1.202
10,000–20,000	−1.235	0.291	0.031	2.697	−2.098 *	0.123	0.032	9.016
20,000–40,000	−1.298	0.273	0.029	2.592	−1.998 **	0.136	0.017	4.490
Neighborhood and social support								
Number of relatives	−0.038	0.962	0.785	1.179	0.014	1.014	0.771	1.333
Neighborhood relations	−0.013	0.987	0.942	1.034	0.239 ***	1.270	1.213	1.331
Number of acquaintances	−	−	−	−	0.086	1.089	0.868	1.367
Density of medical facilities	0.077 ***	1.080	1.028	1.133	−	−	−	−

Note: The dependent variable 1 refers to good health and 0 refers to poor health. # refers to reference variables (control group). represents no parameter, which means that the variable is not in the model. * indicates 0.1 significance level, ** indicates 0.01 significance level and *** indicates a significance level of 0.005 or above.

Table 11. The influence model of residential characteristics on residents' health.

Variable	Physical Health (Cox and Snell R ² = 0.194, Accuracy = 76.8%)				Mental Health (Cox and Snell R ² = 0.219, Accuracy = 72.7%)			
	Coef.	S.E.	95% CI		Coef.	S.E.	95% CI	
			Lower Limit	Upper Limit			Lower Limit	Upper Limit
Relocation characteristics								
Relocation willingness # actively								
Negative	−0.896 *	0.408	0.207	0.804	0.045	1.046	0.533	2.053
Relocation distance	0.003	1.003	0.967	1.040	−0.039 *	0.962	0.930	0.994
Relocation direction # outer city- outer city								
inner city-inner city	−0.488	0.614	0.203	1.852	0.874 *	2.396	0.946	6.067
inner city-outer city	−0.418	0.659	0.215	2.019	0.830 *	2.292	0.863	6.091
outer city-inner city	−0.056	0.945	0.311	2.874	−0.518	0.596	0.225	1.576
Personal habits								
Smoking # Yes	−0.250	0.779	0.423	1.435	0.214	1.239	0.700	2.193
Drinking # Yes	−0.250	0.779	0.471	1.288	−0.078	0.925	0.588	1.453
Exercise # Yes	−0.709 ***	0.492	0.324	0.747	−0.242	0.785	0.537	1.148
Individual socio-economic attributes								
Gender # Female	−0.161	0.852	0.477	1.519	0.028	1.029	0.595	1.778
Age	−0.086 ***	0.918	0.902	0.934	−0.012	0.988	0.973	1.003
Marital status # unmarried								
Married	0.469	1.598	0.889	2.874	−0.491 *	0.612	0.367	1.021
Divorced or widowed	−20.223	0.000	0.000	0.000	−0.487	0.614	0.024	15.910
Annual family income #More than 40,000								
Less than 10,000	−0.886	0.412	0.048	3.513	−2.696 *	0.067	0.006	0.811
10,000–20,000	−1.016	0.362	0.043	3.016	−2.253 *	0.105	0.009	1.244
20,000–40,000	−1.084	0.338	0.039	2.897	−2.013	0.134	0.011	1.621
Neighborhood and social support								
Number of relatives	−0.010	0.990	0.784	1.252	0.062	1.064	0.768	1.475
Neighborhood relations	−0.042	0.959	0.909	1.011	0.235 ***	1.264	1.196	1.337
Number of acquaintances	−	−	−	−	0.182	1.200	0.920	1.564
Density of medical facilities	0.110 ***	1.116	1.053	1.183	−	−	−	−

Note: The dependent variable 1 refers to good health and 0 refers to poor health. # refers to reference variables (control group). represents no parameter, which means that the variable is not in the model. * indicates 0.1 significance level and *** indicates a significance level of 0.005 or above.

As a result of these multiple factors, the willingness to relocate has no significant impact on the physical health of the elderly, and relocation is not conducive to the maintenance of the elderly's physical health. The model results outline that the longer the relocation distance, the greater the possibility of mental illness among the elderly, but this indicator has no significant impact on physical health. The closer the relocation distance, the less difficult it is for the elderly to adapt to the new environment, which is more conducive

to the maintenance of mental health among the elderly. In terms of relocation direction, compared with relocation within the outer circle, internal and centrifugal relocation within the core area has a positive effect on the mental health of the elderly. Generally, the core area is relatively small, and various public service facilities are relatively complete [42]. Thus, the elderly have a short relocation distance in urban core areas and little environmental change. Compared with cross-regional relocation, relocation to the core area is more conducive to maintaining the psychological health of the elderly. Studies have shown that the elderly move from the main urban area to the suburbs to obtain better living conditions [38]. From this study, the relocation of the main city to the outer ring is more conducive to the psychological health of the elderly; however, the relocation direction has no significant impact on the physical health of the elderly.

4. Discussion

4.1. Frequent Residential Relocation Negatively Impacts Elderly's Health

We controlled for the indicators related to social and economic attributes among the elderly, living habits and neighborhood social support. The results of the model show that frequent residential relocation has a significant negative impact on the physical and mental health of the elderly. Specifically, the elderly's residential relocation frequency within 3–5 years has a significant negative impact on their health, specifying that there is a short-term effect of residential relocation behavior on their health. This result is similar to existing research findings [44]. This study conducts statistical analysis on the relocation behavior of residents in major developed countries internationally. The study classified and described residents by different age groups, believing that frequent relocation in urban areas can make it difficult for elderly people to adapt to different living environments, leading to internal anxiety and health damage. There are other papers that focus on the impact of different racial immigrants' relocation behavior in cities on life satisfaction from the perspective of differences socio-economic background [45]. The results indicate that the majority of elderly people have weak socio-economic activities, and frequent relocation behaviors can disrupt their daily habits, leading to psychological anxiety and unease [45]. In the past year, the elderly's residential relocation frequency had a significant negative impact on their physical health but had no significant impact on their mental health. The results showed that short-term residential relocation behavior greatly consumed the elderly's energy, and the elderly needed to readapt to the external environment. The negative effects of residential relocation frequency on the physical and mental health of the elderly were significant, but the negative effects were weakened after the elderly adapted to the new living environment.

4.2. The Health Effects of Residential Relocation on Different Stages Are Heterogeneous

The cumulative effect of residential relocation harmed the physical and mental health of the elderly. In terms of cumulative effects, frequent residential relocation among the elderly in the past 5 years had a significant negative impact on their health. In the past 3 years, residential relocation behavior has significantly affected the physiological health of the elderly. In terms of short-term effects, the shorter the elderly moved to a new residence, the more significant their physical and mental health would be. The results of this article are similar to the existing studies. After elderly people move to new homes, it takes them a long time to adapt to the surrounding environment and stabilize their inner emotions [46]. Multiple relocations within a fixed time quantum will accumulate psychological stress of the elderly, and long-term anxiety will also lead to a decline in the health level of the elderly [49,57]. In terms of the characteristics of residential relocation behavior, the elderly's active residential relocation had a significant positive impact on their physiological health. Residential relocation distance has a significant negative impact on the mental health of the elderly. Centrifugal residential relocation (from the main urban area to the surrounding new urban area) had a significant positive impact on the mental health of the elderly (Table 12).

Table 12. Effect of relocation on residents' physical and mental health.

Type	Primary Indicators	Secondary Indicators	Physical Health OR [95% CI]	Mental Health OR [95% CI]
Cumulative effects	Relocation frequency	once within 5 years	↓0.695 [0.502–0.963]	↓0.496 [0.345–0.714]
		2–3 times within 5 years	/	/
		4–5 times within 5 years	↓0.515 [0.345–0.769]	/
Short-term effects	Relocation time (# 5 + years)	Within 1 year	↓0.287 [0.135–0.608]	↓0.342 [0.165–0.706]
		2–3 years	/	↓0.571 [0.366–0.871]
		3–5 years	/	/
Relocation characteristics effects	Relocation willingness (# Active)	Passive	↓0.408 [0.207–0.804]	/
	Relocation direction (# outer→outer)	Inner city→Inner city	/	↑2.396 [0.946–6.067]
		Outer city→Inner city	/	↑2.292 [0.863–6.091]
		Inner city→Outer city	/	/
	Relocation distance	/	/	↓0.962 [0.930–0.994]

Note: Among the measurement indicators, “healthy” is defined as 1, and “unhealthy” is defined as 0; #; ↑ represents a positive impact, ↓ represents a negative impact, and / represents no significant impact.

4.3. The Impact of Relocation on Health Shows a Multifactor Mixed Cross Action

In previous studies, sociologists and psychologists have used the social-ecological theory to describe the impact of the external environment on human behavior and psychology [18]. This theory regards people in society as creatures in the ecosystem and believes that human behavior and psychological state are jointly affected by internal factors (emotion, motivation, belief, etc.) and external factors (social environment, policy environment, economic conditions, etc.) [38,58]. Based on the theoretical model of social ecology, we built a mechanistic model of the impact of relocation on residents' physical and mental health, as illustrated in Figure 7. The frequency, duration, direction and distance of relocation are external factors, whereas willingness to relocate is an internal factor. Additionally, personal physical and mental health, as the dependent variables of the model, are also internal factors. It can be seen from the analysis results that the relocation will consume the energy of the elderly, which causes the elderly to not adapt to a new environment within a certain period. Therefore, relocation activity is not conducive to the physical and mental health of the elderly in the short term. Furthermore, the longer relocation distance makes it more difficult for the elderly to adapt to the new environment, thereby enhancing the negative impact on their mental health. At the same time, the high frequency of relocation will also overdraw the physical strength of the elderly, which is not conducive to their physical and mental health. From the perspective of the built environment, most newly built residential areas in Nanjing are located in the suburbs. These residential areas have good natural environments, low building densities and complete public service facilities. Elderly people further improved their living conditions through active outward relocation activities. A good living environment is conducive to maintaining the physical and mental health of older adults.

4.4. The Living Habits and External Environment Have a Significant Impact on the Elderly's Health

In terms of control variables, the elderly's personal habits had a significant impact on their physiological health. Specifically, elderly people who do not exercise regularly are more likely to be physically unhealthy. This conclusion is consistent with the general cognition that regular exercise is beneficial to improving residents' physiological health in existing studies [49]. In the socio-economic attributes, age has a significant negative impact on the physical health of the elderly. With increasing age, it becomes more difficult for the elderly to maintain their physical health. This conclusion is consistent with the general decline in physical health among the elderly [50]. Marital status has a significant impact on the mental health of older adults. Unmarried and widowed elderly are more likely to be psychologically unhealthy. Elderly widowed people may bear greater economic

pressure, which negatively affects their mental health. Annual family income also has a significant impact on the mental health of the elderly. Compared with residents with an income of more than 40,000, the elderly with an income of less than 10,000, 10,000 to 20,000 and 20,000 to 40,000 are more likely to be psychologically unhealthy. This conclusion is consistent with existing research that high-income groups are more likely to avoid mental health problems [59]. The higher the accessibility of medical facilities around the residential area, the significantly positive the impact on physical health among the elderly. Generally, when medical facilities around the residential area are abundant, the higher the convenience of the elderly in obtaining medical resources, the greater the probability of the elderly maintaining physical health. Moreover, a good neighborhood relationship can significantly and positively affect the mental health of the elderly, which is consistent with the conclusions of previous studies [60].

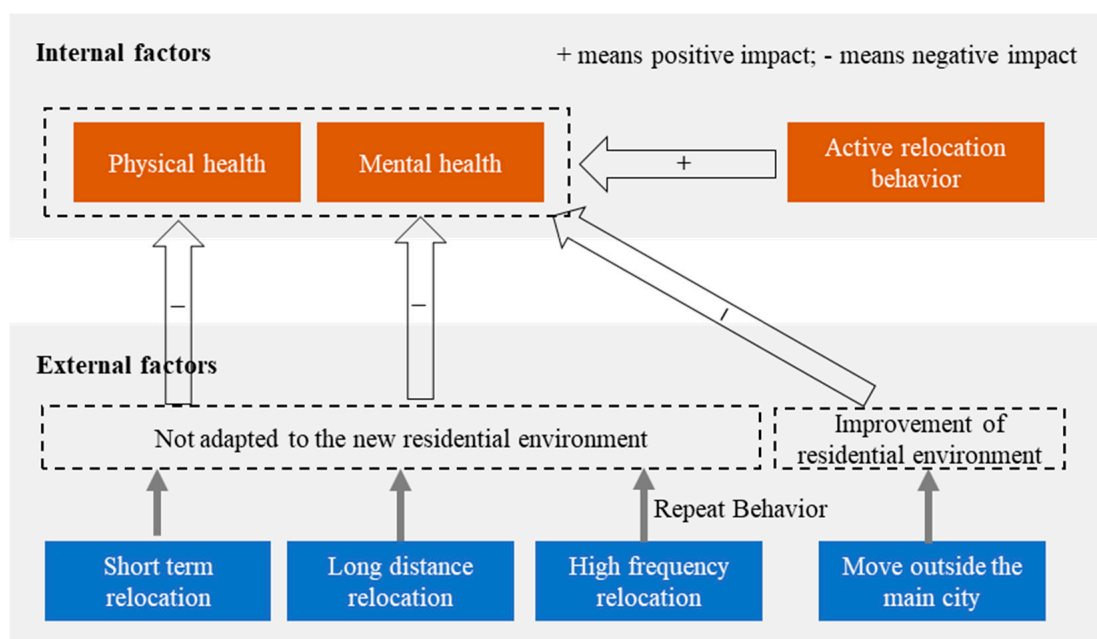


Figure 7. The influence path of relocation on residents' physical and mental health.

5. Conclusions

5.1. Key Findings

Taking Nanjing as an example, this study used binomial logistic regression analysis and in-depth interviews to study relocation behavior. We used 2019 household survey questionnaire data. This paper analyses the influence of the spatial and temporal characteristics of the elderly's relocation, the accumulation effect at different stages and the willingness to move on the physical and mental health among the elderly. The findings show that the effects of relocation on elderly health include long-term cumulative effects and short-term effects, which are mainly reflected in the following aspects.

- (1) The frequency of relocation of residents in Nanjing has generally increased and has increased significantly since 2000. From the perspective of spatial distribution patterns, the ratio of the elderly moving from the peripheral suburbs to the main urban area was high, and only a small proportion of the elderly moved from the main city to the suburban new town;
- (2) Frequent relocation harms the health of the elderly. The long-term cumulative effect is shown as the negative impact of frequent relocation over the past 5 years on the physical and mental health of the elderly. The short-term effect refers to the negative impact of the elderly's relocation on their mental health in the short term;

- (3) Different relocation characteristics had different effects on health. Regarding the last relocation activity, active relocation had a significant positive impact on physical health, centrifugal relocation had a significant positive impact on mental health and long-distance relocation had a significant negative impact on mental health;
- (4) The effect of relocation on health is multifactorial. The longer relocation distance makes it more difficult for the elderly to adapt to the new environment, which has a significant negative impact on their psychological health. At the same time, high frequency relocation consumes a lot of the physical strength of the elderly, which is not conducive to their physical and mental health.

5.2. Implications

This study summarizes the time–space characteristics of relocation from the perspective of geography and analyses the impact of relocation behavior on health under long-term and short-term time effects. This study evaluated the differential effects of relocation distance, direction and intention on residents' physical and mental health. From the perspective of geography, this study supplements relevant theoretical research results on relocation behavior. Generally, urban internal relocation has a significant impact on the elderly's health. The physical health of the elderly was significantly affected by long-term cumulative effects, while their mental health was significantly affected by short-term effects. Both the short- and long-term effects of relocation adversely affected residents' physical and mental health. The state needs to formulate a planning policy to maintain long-term stable residences for the elderly. A stable living environment is conducive to improving the physical and mental health of older adults. Stable social relationships and close neighborhood exchanges are conducive to the physical and mental health of the elderly. The government should actively build a stable community relationship network, and relevant positive measures will be conducive to improving residents' health. For the elderly population, the focus of relocation is to build a familiar neighborhood environment. A familiar neighborhood environment can enhance the elderly's social interaction level, alleviate their psychological anxiety and loneliness and help maintain a healthy living state for the elderly. On the other hand, the renewal of old urban residential areas should not simply adopt the development model of inner-city demolition and suburban reconstruction. The location environment remains the primary factor affecting the living quality for the elderly. A good neighborhood environment plays a greater role than the quality of residential buildings. The community construction should strengthen the creation of an aging-friendly environment, allowing elderly people to quickly integrate into the community's life circle and neighborhood social networks, and improving their sense of happiness and satisfaction.

5.3. Limitations and Future Research Directions

Through a follow-up survey of the health status of the elderly, this study discusses the mechanism of the impact of relocation on health. However, there are still some areas worth discussing in this study. First, the positive effect of active relocation and the negative effect of relocation intersect. Second, the adaptation period of the elderly to a new residence was not fixed. These findings need to be further analyzed in future research. Moreover, it is difficult to explain the short-term effect mechanism of relocation on health and deconstruct the mechanism of external factors on direct variables, such as relocation duration, through models. This article selects the elderly population as the research object, which has limitations in sample selection, and the sampling proportion still needs further verification. We cannot accurately obtain the proportion and location of the elderly population in urban areas. We selected several representative residential areas with a large number of elderly people for sampling surveys, but the distribution of the samples did not cover the entire city and there is still bias. In the next step, we will conduct more extensive sample research to improve the explanatory power of the model results.

In future research, we will explain the impact of relocation on health through longitudinal follow-up research on health status. We will further analyze the self-regulation

process of the short-term effects of relocation on the health of the elderly. We will track the elderly's health across 3 months, 6 months and 1 year. Additionally, we will conduct in-depth interviews and other research methods, focusing on a more comprehensive discussion of the mechanism of the impact of relocation on health. In a follow-up study, we also plan to conduct in-depth research on population differentiation and combine social spatial differentiation with relocation to conduct cross-cutting research in multiple fields. Social spatial differentiation and relocation may have an interactive relationship, and we will perform structural equation modelling to conduct an in-depth analysis of their structural relationships in a follow-up study.

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