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ORIGINAL RESEARCH

Progressive Relationship Between Sustainable Development of Elderly Care Institutions and Spatial Environmental Factors: A Study Based on the Influence of Supermarkets, Medical Accessibility, and Parks in Urban Areas

Hua Jiang[1], Zhiyang Guo[1], Yuqian Zhang[1], Hangkong Zhang[2]

[1]School of Labor Economics, Capital University of Economics and Business (CUEB), Beijing, People's Republic of China; [2]Institute of Gerontology, Renmin University of China (RUC), Beijing, People's Republic of China

Correspondence: Yuqian Zhang, Capital University of Economics and Business, Flower-Town, Fengtai District, Beijing, 100070, People's Republic of China, Tel +86-13240943824, Email yqzhangdd@Outlook.com

Purpose: To study the relationship between three variables, namely, the number of supermarkets around, the average distance to medical institutions designated to be covered by basic medical insurance, and the presence of parks around, and the sustainable development of elderly care institutions.

Patients and Methods: This paper is based on the census database of elderly care institutions in Beijing. We ran a self-developed Python program to mine the database after adding three variables, namely, the number of supermarkets around, the average distance to medical institutions designated to be covered by basic medical insurance (hereinafter referred to as "designated medical institutions"), and the presence of parks around, and then used the least squares method in regression analysis.

Results: The number of years of depreciation for fixed assets had some degree of influence on the occupancy rate of an elderly care institution under sustained operation. The occupancy rate of above 80% was efficient for an elderly care institution. There was a progressive relationship between the external spatial factors and the internal resources of an elderly care institution in terms of influencing the occupancy rate of the institution. Optimizing the spatial distribution of elderly care institutions should first optimize the choice of location.

Conclusion: The occupancy rate of an elderly care institution was closely related to the convenience of living conditions and that site selection was crucial for such a facility. We arrived at two recommendations for the future development of elderly care institutions, 1. Reducing the number of the institutions in areas with unfavorable geographic positions and serving senior care needs within an appropriate close distance, so as to better optimize the spatial distribution of senior care facilities, improve the efficiency of resource allocation. 2. Strike a balance between the economic benefits of operating entities and the social benefits associated with older people.

Keywords: elderly care institutions, bed occupancy rate, spacial environment, progressive relationship

Preface

Background and Current Situation

The construction of elderly service facilities could not only promote the development of the old-age service industry, but also offer an effective means to address the social problems associated with population aging. As proposed in the Opinions of the General Office of the State Council on Promoting the Development of Elderly Care Services, a document released in 2019, China would fully invigorate the elderly service market, expand effective social investment, and substantially meet the diversified elderly service needs of older people on the basis of making basic elderly services available for all by 2022. The following year, the Beijing Municipal Civil Affairs Bureau and the Beijing Municipal

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Commission of Planning and Natural Resources jointly released the Beijing Elderly Service Program (2018–2035), which emphasized the integration and planning of social resources for the development of elderly care services, guided by the concepts of revitalizing resources in reserve and joint construction for shared use. Besides, the State Council also issued a guideline to promote the development of the national undertakings for the aged and improve the elderly care service system during the 14th Five-Year Plan period, which proposed "implementing the national strategy to actively cope with population aging and promoting the coordinated development of elderly care programs and industries" and indicated that elderly care institutions are great underpinnings for the development of elderly care programs and industries.

Currently, Chinese elderly care institutions face the dual challenges of "shortage of beds" and "shortage of caregivers". In recent years, with the deepening of population aging in China, there has been a rapid growth in demand for elderly care, and the previous single supply of elderly care institutions can no longer meet the diverse and hierarchical needs of the elderly. Although the government has taken measures to increase the supply of elderly care beds, the problem of bed shortages persists in some elderly care institutions. In addition, the bed occupancy rate and admission rate in some elderly care institutions have remained at low levels. According to data from a press conference held by the Ministry of Civil Affairs in July 2020, there are 4.291 million beds in elderly care institutions in China, but only 2.146 million elderly people are actually admitted, leading to a high 50% vacancy rate for elderly care beds.

Previous Research and Contribution

Environment refers to the sum of all external conditions acting on an individual's life, including natural and artificial environments.[1] Spatial environment, mentioned in this paper, refers to the combination of a series of factors that affect the utilization rate of beds in an elderly care institution, such as land use by a material space (eg, medical institutions), transportation system, and urban design.[2] The rapid development of elderly care institutions has been accompanied by some discordance in the spatial environment, which is mainly exemplified by the low bed occupancy rate of elderly care institutions.[3] On the one hand, the overall bed occupancy rate was low. For instance, the bed occupancy rate of Beijing elderly care institutions stood at about 53.0% according to the data from the 2016 census of old-age service facilities in Beijing.[4] On the other hand, it was hard to get a bed in urban areas, while a high proportion of beds were left vacant in suburban areas. Available data suggested that the bed occupancy rate in the suburbs was about 60% of that in urban areas.[5] This phenomenon indicated that there was a correlation between the spatial environment and the bed occupancy rate in elderly care institutions of Beijing. However, the bed occupancy rate of elderly care institutions has been insufficiently explored by Chinese researchers from the perspective of spatial environment, and the existing literature in this regard can be summarized into two aspects: First, some studies selected a part of elderly care institutions in one specific city as a sample for analysis. Take Shanghai for example. Gao Xiangdong and Wang Jing concluded through empirical analysis that elderly care institutions in Shanghai were dense in urban areas and scattered in the suburbs,[6,7] there was still a shortage of beds in the central city,[8] and the spatial distribution and number of elderly care institutions should be planned from the long-term perspective.[7] Second, most of the existing research programs used the spatial accessibility measurement approach to analyze problems. Tao Zhuolin et al applied the improved two-step floating search method to evaluate the elderly care facilities in Beijing, finding that most of them were concentrated in the northern region;[9] Xu Ke et al adopted the same method to evaluate the elderly service facilities in Fuzhou, concluding that the pattern of distribution of these facilities in the city was dense in the center and at decreasing densities towards the periphery;[10] and Li Baojie introduced the nearest neighbor model to examine the spatial characteristics of elderly care institutions in Xuzhou, holding that these institutions became spatially concentrated from the periphery to the downtown randomly and that these institutions featured good accessibility overall.[11] The fact that occupancy rates of elderly care institutions were usually high in urban areas but low in the suburbs was because of the easy access and proximity to medical institutions in urban areas. Despite the higher charges, elderly care institutions in urban areas still held considerable appeal to older people.[12] In addition, the convenience of transportation turned out to be another major factor affecting the occupancy rate.[13]

The existing literature has proposed some general laws governing the distribution and occupancy of elderly care institutions, and relevant researchers mainly attribute low occupancy rates of elderly care institutions to the spatial

environment, that is, whether they are located in urban areas or the suburbs, but the reality is that there are also elderly care institutions that suffer from consistently low occupancy rates, despite their superior locations in central city areas, comfortable internal environment, and complete medical conditions.

Aim

This study aims to explore the association and degree of influence between the occupancy rates of elderly care institutions and spatial environmental factors, as well as the sequential relationship between external spatial factors and internal resource factors in influencing occupancy rates.

Research Questions

The study will investigate the following research questions:

1. Which spatial environmental factors and to what extent are they associated with the occupancy rate (resource utilization efficiency) of an elderly care institution?
2. Is there a progressive relationship between external spatial factors and internal resource factors of elderly care institutions in terms of influencing occupancy rate?
3. Is the occupancy rate of an elderly care institution determined by the geographic location or the internal service conditions?

To answer these questions, this paper made the theoretical hypotheses: the factors influencing the occupancy rate are divided into spatial environment factors and internal resource factors, and there is a progressive relationship between the two categories of factors; spatial environment factors are underlying factors that affect the occupancy rate of an elderly care institution, and only with sound underlying factors, can internal resource factors of the institution effectively boost the occupancy rate; otherwise, the allocation of internal resources by the institution will not be able to sharply increase the occupancy rate.

Research Mechanism

The sustainable development of elderly care institutions hinges on continuous and stable income, The operational mechanism for the sustainable development of these institutions is illustrated in Figure 1. When the income of an elderly care institution exceeds its costs, it generates annual surpluses, ensuring the continuous operation of the institution. However, if the income of the institution is insufficient to cover its costs, it incurs annual losses, eventually leading to the institution's withdrawal from the market. The high income comes from the high occupancy rate of elderly care institutions, which can generate operating income and then a state of surplus.

According to the theory of cost behavior analysis in the financial accounting system, costs of elderly care institutions are divided into fixed costs and variable costs according to the relations with the number of residents. Fixed costs are the costs that remain constant over a certain period of time and are expressed in accounting as those that are not affected by changes in business volume. The most commonly-seen forms of fixed cost are houses and buildings and equipment in fixed assets, etc. The costs in this category are amortized to operating costs by spreading the total value of costs over the

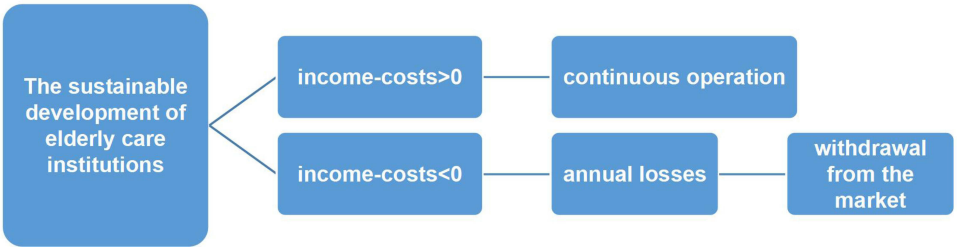

Figure 1 The operational mechanism for the sustainable development of elderly care institutions.

accounting period and depreciating them through to the approved method for the depreciable life. Variable costs refer to operating costs, which are definitely incurred annually and are apportioned according to the number of elderly residents. They mainly consist of bills of water, electricity, and gas supply, personnel costs such as salary expenses, rent, taxes, and other expenses. Of these, bills of water, electricity, and gas supply and other expenses are proportional to the occupancy rate; personnel costs such as salary expenses positively correlate with the occupancy rate under the constraint of the "number of elderly residents/caregivers" ratio (α); and there is zero marginal cost to rent and taxes as the occupancy rate change. Thus, the total operating costs of an elderly care institution are calculated with the following equation:

$$C = \frac{C_0}{12n} + x\lambda \times (c_1 + c_5) + x \times (c_3 + c_4) + \frac{x\lambda c_2}{\alpha} \tag{1}$$

where C is the total operating costs, C_0 is the original value of fixed costs, n is the number of years of depreciation for fixed costs, 12n is the total number of months, x is the total number of beds designed, λ is the bed occupancy rate, c_1 is the per capita bills of water, electricity, and gas supply, c_2 is the per capita caregiver pay, c_3 is the rent per bed, c_4 is the taxes per bed, and c_5 is the per capita other expenses.

Revenue of an elderly care institution is usually divided into two categories: operating income and government subsidy income. Operating income refers to the income generated by each additional resident, which generally consists of bed fees, meal fees, nursing fees, and other related fees charged on older persons. Different rates are applied depending on the levels of care needed by senior people (grouped into those who do not need elderly care, those who need some elderly care, and those who entirely rely on elderly care). Government subsidy income refers to the income obtained from government in various forms of subsidies, such as construction subsidy, operation subsidy, personnel subsidy, rent subsidy, and other related subsidies for the newly built, expanded, reconstructed, and operated elderly care institutions in order to accelerate the construction and sustainable development of care facilities for the aged. The equation for the total income of an elderly care institution is obtained as below:

$$Y = x\lambda \times \bar{y} + x(t_1 + t_4 + t_5) + x\lambda \times t_2 + x\lambda t_3/\alpha \tag{2}$$

where Y is the revenue; $\bar{y}$ is the per capita rate weighted by the rates charged on residents who do not need elderly care, residents who need some elderly care, and residents who entirely rely on elderly care; t_1 is the construction subsidy received, t_4 is the rent subsidy, and t_5 is other related subsidies, all of which are calculated given the number of beds (x); t_2 is the operation subsidy, which is calculated given the actual number of residents; and t_3 is the personnel subsidy, which is calculated given the number of nursing staff. The per capita rate $\bar{y} = 3,097.70$ in (Equation 2) is computed with the following equation:

$$\bar{y} = \frac{a_1 \times b_1 + a_2 \times b_2 + a_3 \times b_3}{a_1 + a_2 + a_3} \tag{3}$$

where a_1, a_2, and a_3 are the number of residents who do not need elderly care, the number of residents who need some elderly care, and the number of residents who entirely rely on elderly care and b_1, b_2, and b_3 are the sum of the bed fees, meal fees, nursing fees, and other fees charged on the aforesaid three types of residents.

The basic condition for an elderly care institution to achieve sustainable operation is $Y - C > 0$. By associating (Equation 1) with (Equation 2), the bed occupancy rate of the elderly care institution can be obtained as follows:

$$\lambda > \frac{\frac{1}{12n} c_0 + x\ (c_3 + c_4 - t_1 - t_4 - t_5)}{x\ (\bar{y} + t_2 + \frac{1}{\alpha} t_3 - c_1 - c_5 - \frac{1}{\alpha} c_2)} \tag{4}$$

The data from the census of local elderly care institutions conducted by the Beijing Municipal Civil Affairs Bureau (hereinafter referred to as "BMCAB") (see the data sources presented later for the data description) were used to execute a series of calculation steps to get the following results for these institutions. The average value of fixed assets c_0= 82,314,900 yuan, the average number of beds designed was x= 209.87, the bills of water, electricity, and gas supply per resident was c_1= 469.36 yuan per month, the per capita monthly caregiver pay was c_2=3266.72 yuan, the average rent per bed was c_3=394.70 yuan per month, the taxes per bed was c_4=144 yuan per month, and other expenses per resident was c_5=956.09 yuan per month, construction subsidy per bed was t_1=108.06 yuan per month, operating subsidy per resident

was t_2=658.77 yuan per month, per capita personnel subsidy was t_3=1259.65 yuan per month (see Questionnaire F1), rent subsidy per bed was t_4=90.59 yuan per month, and other related subsidies per bed was t_5=102.69 yuan per month, the resident-to-caregiver ratio was α=7.36, and the weighted per capita rate was $\bar{y} = 3,097.70$ yuan per month. According to China's tax laws and accounting standards, the minimum depreciation period for general buildings is 20 years, and that for equipment is 10 years. For an elderly care institution, buildings make up the bulk of its fixed costs in operation, while the equipment recorded in fixed costs can be ignored relative to buildings. Furthermore, the nonprofit nature of elderly care institutions determines their long-term operation. Combined with the availability of data, the numbers of depreciable years for fixed costs were set as n=20, n=25, and n=30 in this paper. Substituting the above data into (Equation 4), we could get the bed occupancy rate when an elderly care institution is in sustainable operation, and the bed occupancy rates when the profitability levels $\eta = (Y - C)/Y > 1\%, \eta > 2\%,$ and $\eta > 3\%$, providing n=25:

$$\lambda > \begin{cases} 0.9093 & n = 20 \\ 0.7505 & n = 25 \\ 0.6446 & n = 30 \end{cases}$$

$$\lambda > \begin{cases} 0.7666 & n = 25, \eta > 1\% \\ 0.8004 & n = 25, \eta > 2\% \\ 0.8552 & n = 25, \eta > 3\% \end{cases}$$

A general pattern that can be seen in the foregoing calculations is that when fixed costs are depreciated over a minimum of 20 years, an elder care institution, if wanting to ensure sustainable operations, needs to maintain the bed occupancy rate above 90.93%; when the medium depreciable period of 25 years is adopted, the aforesaid bed occupancy rate would be above 75.05%; and in the case of the long depreciable period of 30 years, the minimum bed occupancy rate would go further down to 64.46%. Although the depreciable periods of fixed assets affect the occupancy rates required to achieve sustainable operation, the depreciable life once determined cannot be changed arbitrarily according to China's tax laws and accounting standards. Thus, to attain sustainable development, an elderly care institution should maintain a steadily high occupancy rate. Only in this way, can related resources be used efficiently. If the meager profitability of elderly care institutions as a type of social organizations is taken into account, the minimum occupancy rates required for sustainable operation would be 0.7666, 0.8004, and 0.8552 when the depreciable period n=25 and profitability levels (η) are set at 1%, 2%, and 3%. Thereby it is known that it is ideal and efficient to keep the occupancy rate of such an institution above 80%. Where beds are left vacant for a long time, there will be a continuous loss and the institution cannot survive. Then, is the high occupancy rate up to spatial environment factors, and what are these factors? To answer these questions, we in this paper referred to the Construction Standards for Elderly Nursing Homes, a document jointly compiled by the Ministry of Housing and Urban-Rural Development and the National Development and Reform Commission in 2010, which proposed that new elderly care institutions should be located in areas with convenient transportation and sound living, medical, and other public service facilities. Based on the theoretical hypothesis that there is a progressive relationship between the spatial environment factors and internal resource factors, we selected three spatial environment factors, namely, the number of supermarkets around, the average distance to designated medical institutions, and the presence of parks around as research variables in this paper. Specifically, the number of supermarkets around reflects the population density, building density, traffic access, and convenience of living in the place where an elderly care institution is located; the average distance to medical institutions reveals the degree of ease with which senior citizens access medical resources, a rigid demand for them; and the presence of parks around indicates the level of satisfaction of leisure needs arising from the aged. With these variables, the following hypotheses are proposed:

Hypothesis 1: The number of supermarkets around has a significant positive effect on the occupancy rate.

Hypothesis 2: The number of parks around has a significant positive effect on the occupancy rate.

Hypothesis 3: The average distance to medical institutions has a significant positive effect on the occupancy rate.

Hypothesis 4: Other internal resource factors have some effect on the occupancy rate, and contribute to the significance of the number of supermarkets around.

In this paper, the census data of elderly care institutions in Beijing were used to study the progressive relationship between the bed occupancy rate and spatial environmental factors with the least squares method, so as to come up with some policy suggestions for improving the use efficiency of beds in elderly care institutions and to further enrich the existing research results.

Data Mining and Research Design

Data Sources and Mining Techniques

This paper is based on the data from a census of local elderly care institutions in Beijing carried out by Peking University under the entrustment of the BMCAB, and the deadline for data submission is 0:00 on September 22, 2016. The census covered 460 elderly care institutions, which consisted of 115 publicly owned and publicly operated institutions, 97 publicly owned and privately operated institutions, 25 publicly constructed and privately operated institutions, and 189 privately owned and privately operated institutions. In the step of data processing, the publicly owned and privately operated institutions were merged into the publicly constructed and privately operated institutions, so there were three types of institutions studied in this paper.

To adapt the census data to the needs of this paper, we mined the original census database by adding variables:

In the first step, the specific addresses of the elderly care institutions in the database were decoded into latitude and longitude coordinates by using the location retrieval function of Baidu's open platform to run the application programming interface (API) and self-developed Python program.

In the second step, three points of interest (POIs) in this paper were selected as hospitals, supermarkets, and parks. In view of the fact that the Construction Standards for Elderly Nursing Homes (2010) did not stipulate the relevant standards for the distances between elderly care institutions and public service facilities, we in this paper took into account the actual geographic conditions of the central city areas in Beijing, the existing research results available at home,[14,15] and the rigid demands for convenient transportation and medical services of older people, among which acute and chronic diseases are prevailing, to define the three POIs as follows. The number of supermarkets around refers to the quantity of supermarkets distributed within 1500 meters of an elderly care institution, the distance to the designated medical institutions means the average distance from an elderly care institution to the designated medical institutions located within 2000 meters of the care facility, and the presence of parks around examines whether there are parks within 2000 meters from an elderly care institution. To figure out the hierarchy of designated medical institutions, we retrieved the medical institutions around an elderly care institution using Python, and then viewed the level of each medical institution by visiting the official website of the BMCAB, going to the "government affairs service" column, and clicking the "information inquiry" function button.

In the third step, an elderly care institution was regarded as a mass point to retrieve the custom distances of the POIs around it. This step was also realized through the self-developed Python program. The walking routes of the elderly were uncertain and complex. To simplify related models, the distances between an elderly care institution and public service facilities around it were straight-line distances.

In the fourth step, to ensure the isotropy of different indicators, the average distance from an elderly care institution to the designated medical institutions within 2000 meters of the facility was defined in the following way: using 2000 meters to minus the distance to a designated medical institution, multiplying the figure obtained from the previous step and 0.1 for a tertiary medical institution, 0.2 for a secondary medical institution, 0.3 for a primary medical institution, or 0.4 for an unrated medical institution, and obtaining the weighted average of the distances to all designated medical institutions before the final standardization step. The process is expressed by the equation as follows:

$$\text{Average distance from an elderly care institution to medical institutions around} = \frac{\sum_{i=1}^{n}(2000 - d_i)\,.\,S_i}{n}$$

where n is the number of medical institutions around an elderly care institution, d_i is the distance to the ith medical institution, S_i is the weight of the ith medical institution, which is 0.1 for a tertiary medical institution, 0.2 for a secondary medical institution, 0.3 for a primary medical institution, and 0.4 for an unrated medical institution.

In the fifth step, the data of other non-categorical variables were standardized.

In the sixth step, 402 valid data entries were finally obtained after those with abnormal occupancy rate values were excluded.

Description of Variables

Dependent Variable

The occupancy rate of an elderly care institution is the dependent variable, which is expressed by the ratio of "the actual number of beds used/the number of beds registered with the BMCAB" in the census of local elderly care institutions.

Independent Variables

The independent variables used in this study are divided into four categories, namely, core variables, service supply, service prices, and institutional characteristics.

Core variables referred to in this paper were spatial environmental factors. An elderly care institution with a large number of supermarkets and parks around is often located in a popular area, which could produce a considerable siphonic effect, a feature that could in turn help the old-age service facility attract more residents. In this paper, it was believed that the average distance to medical institutions had equal importance to the number of supermarkets around and the presence of parks around. Besides, the distance variable has also been used by other scholars in their studies on the occupancy rate of elderly care institutions (Song et al, 2016).

Service supply was explored in this paper from three dimensions. First, the provision of institution-related services. There were two questions in the questionnaire about this: "does the institution provide home care?" and "does this institution provide medical services?" Second, the staffing level. Since most of regular caregivers recruited by Beijing's elderly care institutions have junior high school education or below, this paper used the number of caregivers with the low education level to represent the staff composition. Third, the service quality. This was indicated with a star rating system, a standard that had been formulated by the BMCAB to strictly evaluate the environment, facilities and equipment, personnel literacy, and other indicators of elderly care institutions. The star rating system was chosen in this paper precisely because of its scientificity and rationality.

Service Prices. Usually, the basic charges of an elderly care institution consist of bed fees, meal fees, nursing fees, and sometimes other fees. In this paper, the services provided by an elderly care institution were priced differently depending on the division of residents: those who do not need elderly care, those who need some elderly care, and those who entirely rely on elderly care.

Institutional Characteristics. Elderly care institutions were classified in the questionnaire as those in owned buildings, those in rented buildings, and those in rent-free buildings. They were divided into public institutions as well as private institutions by operation mode, ownership nature, and service objectives. Private institutions could be further divided into publicly owned and privately operated institutions, publicly constructed and privately operated institutions, and privately owned and privately operated institutions. Elderly care institutions could also be broken down into four types, ie small, medium, large, and extra-large institutions depending on the number of beds available.

The descriptive statistics of the variables are shown in Table 1. The average occupancy rate of the elderly care institutions in Beijing was about 52.81%; the average number of supermarkets within 1500 meters of these institutions was about 34.97; the average distance to medical institutions within 2000 meters was about 1017 meters; the average number of regular caregivers with the education level of junior high school or below was around 13; and the average monthly fee for a resident who did not need elderly care stood at about 2513.95 yuan, a resident who needed some elderly care 3010.69 yuan, and a resident who entirely relied on elderly care 3825.76 yuan.

Table 1 Descriptive Statistics of Variables

Variables	Description	Mean	Standard Deviation	Minimum Value	Maximum Value
Dependent variable					
Occupancy rate	The actual number of beds used/the number of beds registered with the BMCAB	52.81	30.802	15	100
Independent variables					
Core variables: Number of supermarkets	Number of supermarkets within 1500 meters	34.97	33.914	0	120
Presence of parks	Presence of parks within 2000 meters. Yes=1, No=0				
Distances to medical institutions	Average distance to medical institutions within 2000 meters	1017.80	532.673	0	1993
Service supply: Home services	Yes=1, No=0				
Medical services	Yes=1, No=0				
Number of caregivers with low education levels	Number of regular caregivers with the level of junior high school or below	13.53	41.994	0	780
Star rating	Comprehensive evaluation of the BMCAB for local elderly care institutions	1.20	1.202	0	5
Service prices		2513.95	2775.359	0	33,000
Rate for a resident not needing elderly service					
Rate for a resident needing some elderly service		3010.69	3208.906	0	36,000
Rate for a resident entirely relying on elderly service		3825.76	4013.636	0	39,000
Institutional characteristics					
Source of buildings	Self-owned buildings=1, rented buildings=2, rent-free buildings=3, other buildings=4				
Operation mode	Public institutions=1, private institutions=2				
Institutional size	Small institution=1, medium institution=2, large institution=3, extra-large institution=4				

Empirical Model

To compare the clarity of the analysis results, we constructed the following benchmark regression model without considering the endogeneity of the occupancy rate of an elderly care institution, and used the multiple regression method to estimate the factors influencing the occupancy rate:

$$Y_i = \beta_0 + \beta_1 Pr + \sum \gamma_i \chi_i + \mu$$

where Y_i is the occupancy rate of the ith elderly care institution, P_r is the core variable, and X_i is the variable of service supply, service price, or institutional characteristics. This paper focused on the core variable factors that affected elderly care institutions. In other words, it examined the positive or negative sign, the numerical value, and the degree of significance of β1.

Empirical Research

Analysis of Model Regression Results

Below are the multiple regression results of the occupancy rate of elderly care institutions using the IBM SPSS Statistics 19 (hereinafter referred to as "SPSS 19") (details can be seen in Table 2).

First, for an elderly care institution, the number of supermarkets within 1500 meters of it, the presence of parks within 2000 meters of it, and the average distance to medical institutions within 2000 meters of it had significant effects on the occupancy rate. The regression results of Model (1) showed that the aforesaid three factors were significant at 10%, 5%

Table 2 Empirical Results

Independent Variables	Dependent Variable = Occupancy Rate				
	(1)	(2)	(3)	(4)	(5)
Core variables					
Number of supermarkets around	0.092* (0.052)	0.132** (0.053)	0.103* (0.054)	0.109** (0.052)	0.166*** (0.055)
Presence of parks around	8.268** (3.941)	7.858** (3.897)	8.205** (3.970)	6.982* (3.941)	6.664* (3.912)
Average distance to medical institutions	−0.018** (0.008)	−0.015* (0.008)	−0.018** (0.008)	−0.016** (0.008)	−0.014* (0.008)
Control variables					
Service supply					
Home services		−4.824 (3.316)			−5.753* (3.387)
Medical services		1.548 (4.031)			2.292 (4.054)
Number of caregivers with the low education level		0.086** (0.035)			0.089** (0.036)
Star rating		3.289** (1.246)			3.285** (1.276)
Service prices					
Rate for a resident not needing elderly service			0.001 (0.002)		0.002 (0.001)
Rate for a resident needing some elderly service			0.000 (0.002)		−0.001 (0.002)
Rate for a resident entirely relying on elderly service			−0.001 (0.001)		−0.001 (0.001)
Institutional characteristics					
Source of buildings				−0.408 (1.788)	0.174 (1.769)
Operation mode				7.827** (3.084)	9.224*** (3.089)
Institutional size				1.039 (1.699)	−1.070 (1.827)
Constant term	56.904*** (4.591)	50.023*** (5.675)	57.454*** (4.673)	43.934*** (8.111)	37.876*** (8.508)

Notes: *, **, and *** denote being significant at 10%, 5%, and 1% significance levels. Values in parentheses are robust standard errors.

and 5% significance levels and the estimated coefficients of the first two factors were positive; the occupancy rate increased by 0.092% and 8.268% per additional supermarket and park around; and a 1 meter increase in the average distance to medical institutions around was associated with a 0.018% fall in the occupancy rate, justifying that there was an obvious connection between the occupancy rate and the average distance to medical facilities around, a finding the same as that of previous studies.

Second, among the service supply factors, the number of caregivers with the low education level and the star rating of an elderly care institution had significant effects on the occupancy rate. Compared with Model (1), Model (2) was used to include service supply for regression. The regression results suggested that an increase in service supply raised the significance level of the number of supermarkets around, reduced the significance level of the average distance to medical institutions, and had no effect on the significance level of the presence of parks around.

Third, service prices did not have a significant impact on the occupancy rate of an elderly care institution. This is mainly because every elderly care institution would pinpoint its own positioning according to internal resources, form a hierarchy of charges, and do consumer profiling for their residents. On the front of older people, they tended to be quite clear on what level and price of elderly service they needed and could afford. Meanwhile, for two elderly care institutions with similar service quality standards, there was no obvious difference in their charges. Model (3) introduced service prices on the basis of Model (1). The model estimation results revealed no change in the significance levels of the above-mentioned three factors. This indicated that the three core variables still played a dominant role in the occupancy rate of elderly care institutions, while service prices only played a complementary role.

Fourth, the operation mode, a variable in the category of institutional characteristics, had a significant effect on the occupancy rate of an elderly care institution. Regression Model (4) showed that the variables of institutional characteristics raised the significance level of the supermarket variable from 10% to 5%, but lowered the significance level of the park variable from 5% to 10%. The above findings, therefore, supported hypotheses 1, 2 and 3 with empirical evidence.

Last, Model (5) included service supply, service prices, and institutional characteristics for regression, and the results suggested that the addition of these control variables greatly raised the significance of the effects produced by the supermarket factor on the occupancy rate from 10% to 1%, while it reduced the significance levels of the other two variables to different extents. An overall look at all five models reveals that the supermarket factor was the biggest factor

influencing the occupancy rate of an elderly care institution, and the addition of other factors only played a complementary role to some extent. Besides, the results of Model (5) also indicated that the more supermarkets around an elderly care institution, the more likely to attract older people. This finding could be explained by the following four reasons. First, the number of supermarkets around is proportional to the population density, building density, living standards, and maturity level of supporting facilities. For the retired, it takes much time to buy groceries in supermarkets alone, so close proximity really matters. Second, for elderly care institutions, advertising costs are less in a place where supermarkets abound. Third, it is convenient for family members when coming to visit their beloved ones who live there and buy daily necessities for them. Fourth, as people grow older, they psychologically prefer a lively atmosphere. Therefore, Hypothesis 4 was supported by empirical evidence in this paper.

Further Analysis: The Effect of Different Distances to Supermarkets on the Occupancy Rate

The above empirical results showed that the number of supermarkets around had a more significant impact on the occupancy rate of an elderly care institution than any other factor. But at what distance from an elderly care institution can these nearby supermarkets have a greater impact on increasing the occupancy rate? The empirical research results of 402 elderly care institutions (Table 3) revealed that the numbers of supermarkets located within 500 meters, 1000 meters, 1500 meters, and 2000 meters of an elderly care institution all had a significant effect on the occupancy rate at the 1% significance level. Even so, there were some differences. On the one hand, from the significance point of view, the value of significance grew larger from 2.7 to 4.7 as the distance increased. On the other hand, in terms of regression coefficient, every one more supermarket within 500 meters had the greatest effect on the increase of occupancy rate, that is, about 0.8 percentage points. As the distance increased, the aforesaid increment narrowed to about 0.28, 0.18, and 0.16 percentage points in the case of 1000 meters, 1500 meters, and 2000 meters.

To verify the robustness of the above regression results and the influence of other factors on the occupancy rate of an elderly care institution, this paper also conducted the regression analysis after adding different distances to supermarkets as a control variable. Below are the empirical results (Table 4):

Service supply: First, visiting services negatively influenced the occupancy rate of an elderly care institution. This might be because older people would prefer home-based care to institutional care. If an elderly care institution provided home care, they could buy such services from the institution when they were in need. As such, the occupancy rate went down to some extent. Second, the number of caregivers with the low education level had a significant positive impact on the occupancy rate of an elderly care institution. Third, the star rating of an elderly care institution had a significant positive effect on the occupancy rate of the institution, probably because the rating was given by the BMCAB, the local authority in charge of elderly care undertakings. In addition, for an elderly care institution, the higher the star rating, the better the reputation. Then its occupancy rate would go up.

Service prices: The empirical results in this paper showed that the fees charged by an elderly care institution had no significant effect on the occupancy rate. This finding aligns with the conclusions drawn by scholars from the National Bureau of Statistics.[4]

Table 3 Regression Results Only Considering the Distances to Supermarkets

Independent Variables	Dependent Variable=Occupancy Rate			
	(1)	(2)	(3)	(4)
Supermarkets within 500 meters	0.808*** (0.291, 2.781)			
Supermarkets within 1000 meters		0.283*** (0.087, 3.269)		
Supermarkets within 1500 meters			0.187*** (0.044, 4.213)	
Supermarkets within 2000 meters				0.164*** (0.035, 4.729)
Constant term	56.392*** (2.064, 27.316)	55.371*** (2.132, 25.968)	53.720*** (2.163, 24.830)	51.976*** (2.305, 22.547)

Notes: ***Denote being significant at 10%, 5%, and 1% significance levels. Values in parentheses are robust standard errors and t values.

Table 4 Regression Results of the Distances to Supermarkets with Control Variables Contained

Independent Variables	Dependent Variable=Occupancy Rate			
	(5)	(6)	(7)	(8)
Supermarkets within 500 meters	1.051*** (0.308, 3.413)			
Supermarkets within 500 meters		0.366*** (0.094, 3.908)		
Supermarkets within 1500 meters			0.243*** (0.048, 5.021)	
Supermarkets within 2000 meters				0.205*** (0.038, 5.457)
Control variables				
Service supply				
Visiting services	−5.265 (3.466,-1.519)	−5.446 (3.441,-1.583)	−6.346* (3.407,-1.863)	−6.365* (3.378,-1.884)
Medical services	3.822 (4.140, 0.923)	3.266 (4.126, 0.791)	2.801 (4.079, 0.687)	2.305 (4.062, 0.568)
Number of caregivers with the low education level	0.094** (0.037, 2.541)	0.096** (0.037, 2.609)	0.094** (0.036, 2.595)	0.094** (0.036, 2.598)
Star rating	3.163** (1.304, 2.425)	3.348** (1.299, 2.577)	3.315** (1.283, 2.584)	3.205** (1.276, 2.512)
Service prices				
Rate for a resident not needing elderly service	0.002 (0.002, 1.013)	0.002 (0.002, 1.270)	0.002 (0.001, 1.337)	0.002 (0.001, 1.079)
Rate for a resident needing some elderly service	0.000 (0.002,-0.143)	−0.001 (0.002,-0.517)	−0.001 (0.002,-0.611)	−0.001 (0.002,-0.454)
Rate for a resident entirely relying on elderly service	−0.001 (0.001,-0.885)	−0.001 (0.001,-0.840)	−0.001 (0.001,-0.993)	−0.001 (0.001,-1.049)
Institutional characteristics				
Source of buildings	0.491 (1.815, 0.271)	−0.033 (1.805,-0.018)	0.087 (1.783, 0.049)	−0.186 (1.774,-0.105)
Operation mode	10.021*** (3.146, 3.185)	9.965*** (3.127, 3.186)	10.303*** (3.091, 3.333)	10.371*** (3.073, 3.374)
Institutional size	−1.160 (1.873,-0.619)	−1.559 (1.855,-0.840)	−0.921 (1.841,-0.501)	−0.922 (1.829,-0.504)
Constant term	34.156*** (7.727, 4.420)	35.592*** (7.581, 4.695)	33.036*** (7.535, 4.384)	32.514*** (7.492, 4.340)

Notes: *, ** and *** denote being significant at 10%, 5%, and 1% significance levels. Values in parentheses are robust standard errors.

Institutional characteristics: Operation mode had a significant positive impact on the occupancy rate of an elderly care institution, which explained why private elderly care institutions usually outperformed their public counterparts in terms of occupancy rate.

Furthermore, the regression analysis results also indicated that the numbers of nearby supermarkets, regardless of different distances, were all very significant, and the significance levels rose and the regression coefficients decreased as the distance increased, a finding consistent with that obtained before control variables were introduced. In addition, it was also evident that the coefficients of the variable—the numbers of nearby supermarkets within 500 meters, 1000 meters, 1500 meters, and 2000 meters—increased after the introduction of the control variable. This partly explained the increase in the occupancy rate of an elder care institution was dominated by the number of supermarkets around, while other factors contributed to a certain extent.

Robustness Test

To verify the robustness of the above results, the following treatments were adopted in this paper. 1. An alternative occupancy rate was calculated to replace this current one using the treatment method of relevant scholars, which was described as new occupancy rate=actual number of elderly people admitted to an elderly care institution÷number of beds registered with the BMCAB×100%.[16] After replacing the dependent variables in models (1)-(5) and models (1)-(8), the direction and significance of the coefficients of the regression results were consistent with those obtained before the replacement, which hence proved the robustness of the regression results originally generated in this paper.

2. Discussions were held around the endogeneity problem. As mentioned above, it is clear that the number of supermarkets around had a significant positive effect on the occupancy rate of an elderly care institution. This situation might also be caused by the endogeneity problem, which arose from the fact that elderly care institutions had unobservable differences in external environment. To ease the endogeneity problem, we needed to find an exogenous instrumental variable that satisfied two conditions at the same time. First, the instrumental variable should be able to explain the differences in the numbers of supermarkets around elderly care institutions. Second, the variable should be exogenous. In other words, it could affect the occupancy rate of an elderly care institution only through the number of supermarkets around, instead of other means. On that basis, this paper used the logarithm of the gross value of wholesale

and retail trade in each district of Beijing as the instrumental variable for the number of supermarkets around. This is because the larger the gross value of wholesale and retail trade means the greater commercial convenience. The high population and building density and mature living facilities would be more likely to fuel the development of various supermarkets. The regression results of the logarithm of the gross value of wholesale and retail trade in each district and the number of supermarkets around an elderly care institution indicated that the two were significantly correlated and that there was no significant correlation between the instrumental variable and the occupancy rate or between the instrumental variable and other control variables. The two-stage least squares (2SLS) method and the generalized method of moments were used to estimate the effect of the instrumental variable. The estimation results generated therefrom were consistent with those produced by the above-mentioned models.

Conclusions and Discussion

In this paper, we drew three useful conclusions after using a multiple linear regression model to analyze the influence of spatial environmental factors on the occupancy rates of the 402 Beijing elderly care institutions, selected from the census organized by the Beijing Municipal Civil Affairs Bureau in 2016. First, the sustainable development of elderly care institutions requires a high occupancy rate. The number of years of depreciation for fixed assets had some influence on the occupancy rate of an elderly care institution under sustainable operation. It was ideal and efficient for such an institution to maintain its occupancy rate above 80%. Second, spatial environmental factors could significantly impact the occupancy rate of an elderly care institution. Some of these factors were the number of supermarkets around, the presence of parks around, and the average distance to medical institutions, among which the number of supermarkets around had more obvious effects on the occupancy rate than other two factors, and one more supermarket around meant an increase in the occupancy rate by 0.17 percentage points. This fully justified that the occupancy rate of an elderly care institution was closely related to the convenience of living there, while other factors could help to enhance the occupancy rate on the basis of the supermarket factor. Third, spatial environment factors played a supportive role in the occupancy rate. In other words, only on the premise of good spatial environment factors, could an elderly care institution raise the occupancy rate by improving the allocation of internal resources.

This paper has verified the positive effects of spatial environmental factors on improving the occupancy rate of an elderly care institution from a new perspective. Of the spatial environmental factors discussed herein, the number of supermarkets around turns out to be the decisive factor in raising the occupancy rate of an elderly care institution. It is therefore concluded that site selection bears critical importance for the development of elderly care institutions. The findings of this paper are helpful for both practice and policy formulation. At a time when actively coping with population aging has risen to a national strategy, elderly care institutions should optimize their geographic distribution in a move to enhance development quality and efficiency. The old institutions that have long maintained a low occupancy rate are recommended to find new locations, if conditions allow, and new institutions should be located in places with convenient living conditions, high population and building density, and easy traffic access as far as possible. For policy makers, it is advised to prioritize considering the possibilities for elderly care institutions to attain sustainable development within the framework of future urban planning, so as to ensure the needs for elderly care can be satisfied in close proximity. With these steps, we will be able to optimize the geographic distribution of elderly care institutions, allocate related resources more efficiently, and strike a balance between the economic benefits of operating entities and the social benefits associated with older people.

Ethics

Our research was conducted under the guidance of the Beijing Municipal Civil Affairs Department, China, and was part of a legally compliant census of home-based elderly care facilities in Beijing. As this survey was entirely organized and executed by a government agency, adhering to all legal and regulatory requisites, it did not necessitate review and approval by an IRB or ethics committee.

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Disclosure

The authors report no conflicts of interest in this work.

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