

Article

Spatiotemporal-Behavior-Based Microsegregation and Differentiated Community Ties of Residents with Different Types of Housing in Mixed-Housing Neighborhoods: A Case Study of Fuzhou, China

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Abstract: As a kind of urban neighborhood with strong internal heterogeneity, mixed-housing neighborhoods have attracted wide attention from scholars in recent years. Strengthening community ties in mixed-housing neighborhoods is of great significance for increasing neighborhood social capital, cultivating a sense of community, and promoting sustainable development of the neighborhood. The neighborhood activities of residents are an important factor in promoting community ties. However, different housing groups in mixed-housing neighborhoods may have differentiated or even segregated overall daily activities, which may impact their neighborhood activities and call for differentiated planning strategies. In this study, we conduct an empirical study in Fuzhou, China, to identify the spatiotemporal-behavior-based microsegregation and differentiated community ties between residents of different types of housing. The data were collected in 2021 and included residents' activity diary data and questionnaire data about neighborhood interaction and community ties. Through an analysis of the daily overall activity space and activities within the neighborhood areas, the spatiotemporal-behavior-based social segregation of various housing groups is depicted. Furthermore, a multigroup structural equation modeling method was used to analyze the relationships among residents' spatiotemporal behaviors, neighborhood interactions, and community ties, and the heterogeneous influence effects across housing groups. The results show that the more residents' activity spaces overlap with the neighborhood area, the more out-of-home time they spend within the neighborhood, and that the more types of activities are conducted within the neighborhood area, the stronger their community ties are. In addition, neighborhood interaction played a linkage role in the relationships of residents' spatiotemporal behaviors and community ties. Our research aims to further the understanding of microsegregation at the neighborhood level and provide references for the development of mixed-housing neighborhoods and urban land use.

Keywords: spatiotemporal behavior; mixed-housing neighborhood; microsegregation; community ties; Fuzhou



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1. Introduction

The enhancement of population heterogeneity within urban neighborhoods has been an important background in urban research in recent decades [1–3]. With rapid urbanization worldwide, the population structure of urban neighborhoods has undergone dramatic changes [4]. The operation of the market economy has expanded the inequality of individuals in socioeconomic backgrounds such as income and education [5]. Increasing labor mobility and migration have strengthened population mobility [6]. At the same time, the gentrification and urban renewal in the inner city have gradually deepened [7]. This profound structural change has made many heterogeneous populations gather and coexist in

neighborhoods, which has enhanced the population heterogeneity of urban neighborhoods. Additionally, different neighborhood relationships and gradually decreasing interpersonal trust have appeared. These factors have led to the possibility of social segregation at the neighborhood level and unprecedented challenges for neighborhood social capital [8,9].

Community ties, also known as bonding social capital, are important forms of neighborhood social capital, referring to the intensity of interactions between people who share the same space [10]. The formation of community ties is influenced by neighborhood activities, personal trust propensities, and individual socioeconomic attributes, such as education, income, race, family size, and length of residence [11]. The ties formed by social connections aggregate people and resources within neighborhoods. The higher the level of social connections, the stronger the community ties form [12]. This may benefit the establishment of personal social networks and neighborhood management [13]. Therefore, in the context of the widespread increase in heterogeneity within urban neighborhoods, strengthening community ties is of great significance.

As a kind of urban neighborhood with strong internal heterogeneity, mixed-housing neighborhoods are formed under the promotion of governments [14]. Since its inception, it has attracted widespread attention from both academia and urban policymakers. In the early stage of the construction of affordable housing, most affordable housing was centrally constructed in urban fringes as separate neighborhoods [15]. However, it has been found in numerous studies that this situation causes inconvenient living conditions for affordable-housing residents and a series of social-segregation-related problems, such as limited access to job opportunities, long-distance commuting, lack of neighborhood activities, loss of community sense, poverty agglomeration, and even polarization [16–18]. Since the 1970s, some countries have proposed mixed-housing policies, such as France's municipal quota policy for social housing [19]. China also began implementing a mixed-residence policy in approximately 2010 [20]. The goal of mixed-housing policies is to mix affordable housing and market housing in the same neighborhood. The underlying assumption is that promoting the proximity of residents with different socioeconomic attributes will improve the living conditions of affordable-housing residents, promote interactions between different social groups, and enhance community social connections [21].

As observed from the perspective of historical institutionalism, the starting point is crucial for the direction of institutional change [22]. Mixed-housing neighborhoods, which are artificially facilitated by external political forces, are different from rural neighborhoods based on villages, with traditional community ties such as blood and family ties [23]. It is also different from neighborhoods formed through pure marketization forces, in which the homogenization characteristics of neighborhood residents are obvious, making it easier to form new community ties [24]. Additionally, it also has different characteristics compared with the socially mixed neighborhoods, which are formed through social or market forces without any policy intervention. For example, this may be because the housing stock is of different ages, creating naturally occurring affordable housing, or the neighborhood is in transition because of gentrification. Community ties in these socially mixed neighborhoods may be intertwined and complex. Unlike these neighborhoods, mixed-housing neighborhoods use government housing policy tools to mix residents of different socioeconomic attributes living in the same neighborhood. Due to the differences among residents, there may exist differences in job–housing relationships, consumption levels, lifestyles, social networks, values, and norms between affordable and market housing groups, which allows the possibility of social stratification within the same neighborhood [25,26]. How to meet the differentiated needs of residents of different housing types and develop community ties for each group of residents in mixed-housing neighborhoods poses challenges for neighborhood management and land-use planning.

Based on a literature review, it is noted that the factors influencing community ties include not only individuals' socioeconomic attributes and trust level but also the neighborhood activities of residents. For example, Carpenter and Takahashi [12] found that gender, age, education, and years of residence have a significant impact on community ties.

Alesina and La Ferrara proposed that a higher level of trust among individuals is more conducive to the formation of community ties. Compared to homogeneous neighborhoods, it was more difficult to improve the level of trust between individuals in heterogeneous neighborhoods [27]. On the other hand, research has found that the more neighborhood activities residents engage in, the easier it is to strengthen individual community ties. For instance, Ross and Searle [28] found that a resident's leisure-time physical activity within the neighborhood was positively associated with his or her community connections. Li et al. [29] found that commuting time has a significant negative impact on residents' neighborhood activity time, which negatively affects neighborhood interaction and community social capital. Ta et al. [30] found that the daily time allocation of different groups led to group differentiation of activity time within neighborhoods, which may lead to different sense of place of the residents. As Wu and Logan [31] argued, the time residents spend in a neighborhood can be seen as a form of investment. Residents who only consider the neighborhood as a space for residing and meeting basic living needs are less likely to perform daily activities in neighborhood areas, let alone socialize with their neighbors and develop strong community ties [32,33]. Therefore, compared to adjusting the structured background of residents (such as income inequality), optimizing residents' spatiotemporal behavior, and enabling them to have more neighborhood activities is a more feasible and practical strategy to strengthen community ties.

In the context of mixed-housing neighborhoods, an increasing number of studies have found that there are significantly different or even segregated daily activities of different housing residents [14,34]. For instance, Chaskin et al. [35] used interview data from Chicago mixed-housing neighborhoods and found that different housing groups employed different parental management that served as a barrier among different groups. Graves [36] investigated a HOPE VI housing redevelopment program and found that housing units were often segregated by tenure and that residents of different housing used different facilities and services within the neighborhood. Therefore, for different housing residents, it is necessary to have a deep understanding of their daily behavioral characteristics and propose differentiated response measures to optimize the daily life activities of different housing groups and promote an increase in their neighborhood activities.

However, existing research has focused more on the characteristics of neighborhood activities themselves among residents of mixed-housing neighborhoods, such as the use of community public space [37], while research on the overall daily activities of different housing residents is still insufficient. Neighborhood activities are only parts of the overall daily activities of residents. The time, space, and types of activities allocated by residents within neighborhoods are closely related to their overall daily activity space, time utilization, and daily life projects [38,39]. Therefore, it is difficult to propose targeted and effective strategies for optimizing the daily activity structure of residents without clarifying the daily overall activity characteristics of residents. In addition, there is a lack of attention to population differences in existing research on the impact path of neighborhood activities promoting community ties. Groups with larger daily activity spaces may be more sensitive to the impact path of neighborhood activities and community ties and therefore will become groups of policy concern. By analyzing the group differences that affect the effects, we can better target the behavioral characteristics of different groups and propose differentiated planning strategies that adapt to group needs, which may improve the efficiency of urban planning and neighborhood management.

Based on the above background and literature review, this paper seeks to address the following two research questions: (1) What are the overall daily activity characteristics of different housing residents in mixed-housing neighborhoods? What are the connections between neighborhood activities and overall daily activities? Is there a segregation of spatiotemporal behavior of different housing groups? (2) How does differentiated daily life affect community ties among different housing groups? What is to be gained when residents feel connected to their neighborhood, even if they only interact with people such as themselves?

We proposed a research framework to investigate the above research questions. As shown in Figure 1, residents' overall daily activity space is assumed to impact residents' activities within the neighborhood. Residents' neighborhood activities are assumed to have direct effects on neighborhood interaction and community ties. Through the direct influence on neighborhood interaction, residents' neighborhood activities may also impact community ties indirectly. We also seek to determine whether there will be significant differences between market- and affordable-housing residents in terms of the influence of individual spatiotemporal behavior and neighborhood interaction on community ties. Furthermore, the socioeconomic variables are hypothesized to both directly and indirectly impact all the endogenous variables. This is because socioeconomic backgrounds affect the overall daily activity space and time allocation of individuals, which may further influence residents' neighborhood activities [40,41]. And socioeconomic variables may also explain neighborhood interaction and community ties [42–44]. Our research aims to further the understanding of microsegregation in mixed-housing neighborhoods and provide references for neighborhood management and urban-land-use planning. Moreover, it should be noted that community ties and residents' neighborhood activities may have a two-way relationship. Greater community ties may also have a positive effect on residents' neighborhood activities. However, in this study, we mainly focus on how residents' daily activities affect community ties, and how to promote more neighborhood activities of residents through planning strategies and adjustments of urban land use. Accordingly, in the framework of this research, we did not test the impact of community ties on residents' behavior.

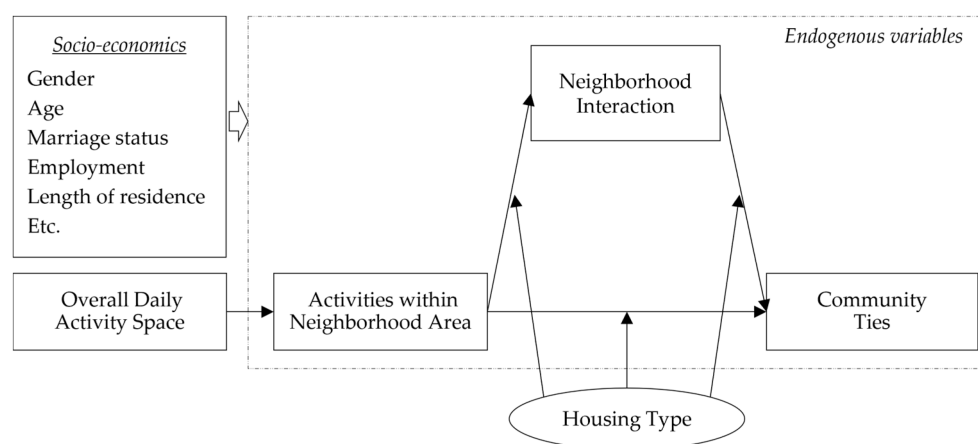


Figure 1. Research framework.

2. Materials and Methods

2.1. Study Area and Data Collection

We take Fuzhou, China, as the study area of our research. Similar to many Western countries, China has also faced various negative social consequences caused by the construction of separate affordable housing neighborhoods. Referring to Western mixed-residence policies, China began adopting a mixed-housing policy in approximately 2010 [14,45]. In 2007 and 2009, the Chinese government issued the “Comments on Solutions to Housing Difficulties of Low-Income Families in Urban Areas” and the “2009–2011 Affordable Housing Guarantee Plan”, respectively [46,47]. These documents recommended integrating affordable housing into the new development of market-housing neighborhoods, with a requirement of at least 20% affordable housing units. As a response, large cities, such as Beijing, Shanghai, Fuzhou, etc., were the first cities to implement this policy. Currently, the mixed-housing policy has been implemented in many provinces in China. Different cities have formulated their localized mixed-housing policy, stipulating the proportion of affordable housing in new development neighborhoods.

Fuzhou, located on the southeast coast of China, is the capital city of Fujian Province (Figure 2). It covers an area of 1761 km² and has a population of 6.64 million. There are two ring roads in Fuzhou. Within the Second Ring Road is the inner city, where most of the urban facilities in the city are located [48]. In the context of the development of mixed-housing neighborhoods in China, Fuzhou is one of the first cities to practice this policy. In the early stage, the affordable housing neighborhoods in Fuzhou were mainly built outside the Third Ring Road, where the urban facilities were insufficient and inconvenient [49]. In 2012, the Housing and Urban–Rural Development Department of Fujian Province issued the crucial “Guidelines for the Construction of ‘Harmonious Living’ in Affordable Housing” in response to the problems caused by the separate construction of affordable housing neighborhoods [50]. This document represented the first provincial government directive in China on mixed-housing policy, emphasizing the importance of creating harmonious and livable affordable housing neighborhoods. Building on these guidelines, the Fuzhou government issued the “Implementation Opinions on Statutorily Building Public Rental Housing on Residential Land through Public Bidding” in 2014, mandating a minimum allocation of 10% of residential building area for affordable housing in publicly tendered residential land [51]. As a result, Fuzhou has made remarkable progress in mixed-housing construction. By the end of 2021, more than 30 mixed-housing neighborhoods had been built in Fuzhou. Among the districts, Jin’an District, Cangshan District, and Taijiang District exhibited the highest concentration of mixed-housing neighborhood construction. Therefore, Fuzhou can serve as a typical representative for studying the development of mixed-housing neighborhoods in Chinese cities, providing a reference for other cities in China and other countries to further optimize mixed-housing policies.

Three mixed-housing neighborhoods in Fuzhou were selected as research cases: Hongjiang neighborhood (HJN), Pushang neighborhood (PSN), and Shanghai Xinyuan neighborhood (SXN) (see Figure 2). These neighborhoods are located in areas with a high concentration of mixed-housing neighborhoods in Fuzhou. All three neighborhoods were built in approximately 2017 as a result of policy interventions by the Chinese government, and the similar construction time helps to minimize the impact of length of residence on residents’ interactions. In terms of neighborhood location, each of the three neighborhoods is unique. Located within the second ring road, SXN is closer to the city center and has high accessibility to urban facilities, forming a convenient living circle. The distribution of surrounding points-of-interest (POIs), such as public transportation, dining services, food markets, convenience stores, shopping malls for shopping facilities, and park plazas and recreation places for leisure facilities, is the highest among the three neighborhoods. HJN and PSN are located between the second and third ring roads in Fuzhou. Specifically, the density of urban facilities around PSN is much lower than that around HJN. Regarding transportation facilities, the number of bus stop POIs around PSN is the lowest among the three neighborhoods. In terms of shopping facilities, there are only scattered convenience stores near the PSN, with no other types of shopping facilities.

The spatial distributions of affordable housing and market housing in each of the three neighborhoods are shown in Figure 3. Specifically, in these three mixed-housing neighborhoods, market- and affordable-housing residents live in separate buildings and are spatially segregated from each other. In HJN, there are a total of 6 affordable housing buildings and 10 market housing buildings. Each building consists of 6 floors and accommodates 150 units. PSN comprises 9 affordable housing buildings and 11 market housing buildings. Each affordable housing building spans 6 floors and accommodates 144 units. In contrast, each market housing building spans 6 floors and accommodates 72 units. SXN has 4 affordable housing buildings and 6 market housing buildings. Each building spans 40 floors and accommodates 400 units.

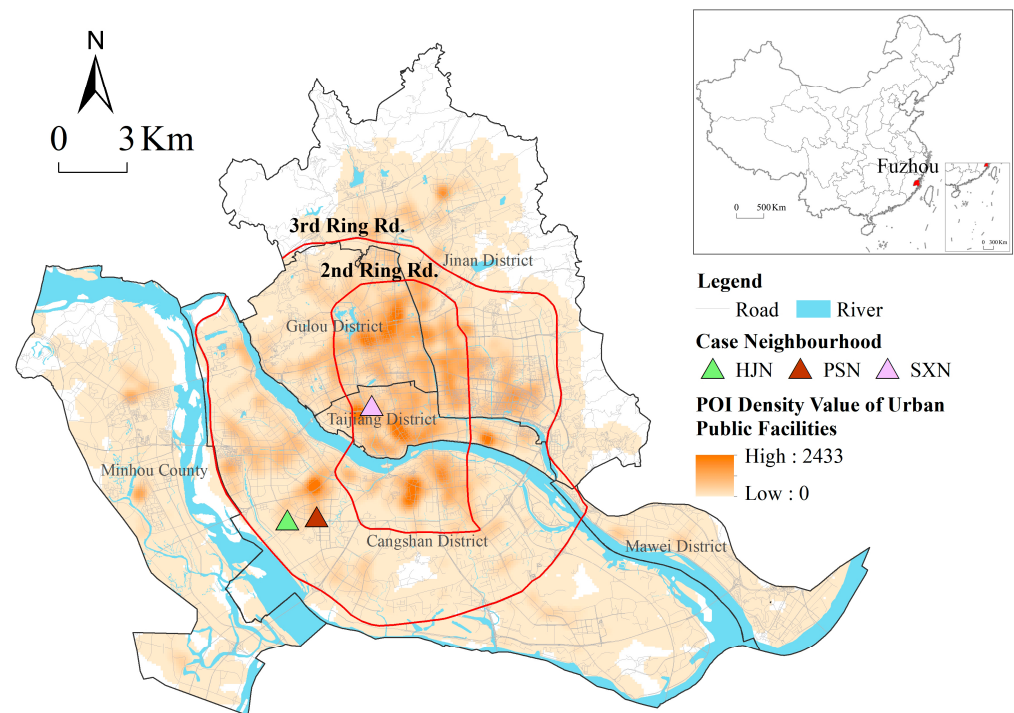


Figure 2. Case study area.

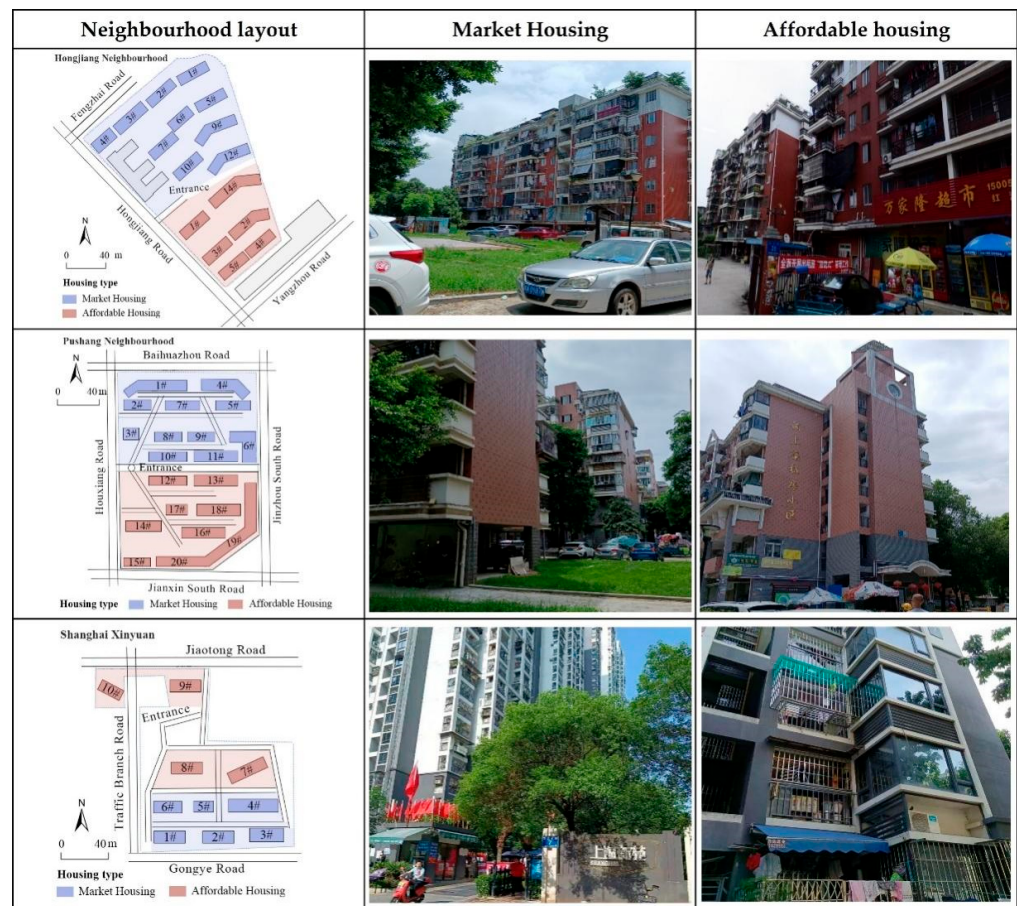


Figure 3. Spatial distribution and photos of different types of housing in case study neighborhoods.

Using a stratified random sampling method, we conducted a survey in these three case study neighborhoods from July to August 2021. To facilitate comparative research between different housing groups, the same number of affordable-housing respondents and market-housing respondents were recruited in each neighborhood. Considering the total population of each case neighborhood, 140 respondents, including 70 affordable-housing residents and 70 market-housing residents, were recruited from each case neighborhood. The contents of the survey included a 48 h activity diary and a questionnaire about residents' neighborhood interactions, community ties, and socioeconomic attributes. The activity diary was used to record the detailed activities and travel information of each sampled resident on a weekday and a weekend day. Each respondent was required to record all activities and travel information of the 2 days (48 h) in chronological order. The information about activities included the start time, end time, activity location, activity type, and space–time flexibility of each activity. After data cleaning and filtering, we finally obtained 380 valid samples. The activity diary dataset included 6744 valid activity records.

The sample profiles are shown in Table 1. In the total sample, the proportions of market housing (MH) and affordable housing (AH) residents are 57.4% and 42.6%, respectively. By using the *t* test method, it was found that there were significant differences in education level, employment status, monthly income, occupation type, children under 16 years old, car ownership, and average job–housing distance between the two groups. These differences are consistent across the three neighborhoods. Residents with market housing show the characteristics of a higher education level, a higher proportion of full-time employment, more employees of government institutions and enterprises, a higher monthly income, a higher proportion of children under 16 years old, a higher car ownership rate, and a longer average job–housing distance than affordable-housing residents.

Table 1. Sample profiles.

	Total Sample (N = 380)				HJN (n = 122)			PSN (n = 131)			SXN (n = 127)		
	Total N = 380	MH n = 218	AH n = 162	p Value	MH n = 66	AH n = 56	p Value	MH n = 77	AH n = 54	p Value	MH n = 75	AH n = 52	p Value
Gender (%)													
Female	48.7	48.2	49.4	0.821	45.5	35.7	0.281	55.8	55.6	0.917	42.7	57.7	0.197
Male	51.3	51.8	50.6		54.5	64.3		44.2	44.4		57.3	42.3	
Age (%)													
<=30	40.3	35.3	46.9	0.102	33.3	35.7	0.440	36.4	44.4	0.143	36.0	61.5	0.205
31–40	29.7	33.5	24.7		30.3	17.9		33.8	33.3		36.0	23.1	
41–50	20.5	20.6	20.4		24.2	26.8		15.6	18.5		22.7	15.4	
>50	9.5	10.6	8.0		12.1	19.6		14.3	3.7		5.3	0.0	
Education (%)													
Middle school or below	26.1	24.8	27.8	0.041 **	24.2	32.1	0.032 **	27.3	31.5	0.029 **	19.2	22.7	0.018 **
High school	31.1	31.7	31.1		37.9	35.2		24.7	25.9		30.8	33.3	
College or undergraduate	41.6	40.7	40.1		36.9	32.1		46.8	42.6		46.1	42.7	
Graduate or higher	1.3	2.9	1.0		1.0	0.5		1.3	0.0		3.8	1.3	
Marriage (%)													
Married	61.8	65.1	57.4	0.131	69.7	69.6	0.154	61.0	55.6	0.53	65.3	46.2	0.032 *
Other status	38.2	34.9	42.6		30.3	30.4		39.0	44.4		34.7	53.8	
Employment (%)													
Full time	77.9	78.0	67.8	0.056 **	80.3	61.4	0.029 **	83.3	64.0	0.067 *	80.0	68.8	0.063 *
Part time	16.6	16.0	27.3		18.2	36.8		11.2	26.9		13.3	23.5	
Unemployed	5.5	6.0	4.9		1.5	1.8		5.6	9.1		6.7	7.7	
Occupation type (%)													
Employees of government institutions and enterprises	47.2	65.3	22.7	0.017 **	65.3	22.5	0.012 **	64.5	24.1	0.015 **	66.2	21.5	0.017 **
Service workers	33.2	22.4	47.8		20.4	47.6		25.3	46.7		21.2	49.2	
Self-employed	19.6	12.3	29.5		14.3	29.9		10.2	29.2		12.6	29.3	
Monthly income (%)													
<2000 RMB	6.7	1.6	10.8	0.043 **	3.1	13.9	0.038 **	2.5	14.8	0.027 **	2.0	19.2	0.004 ***
2000–4000 RMB	52.1	51.4	53.1		48.2	60.2		32.9	67.3		25.3	49.0	
4000–6000 RMB	23.9	27.7	29.1		32.7	20.7		32.5	13.0		46.7	24.6	
6000–10,000 RMB	12.1	13.0	7.0		13.0	5.2		26.9	4.9		20.0	7.2	
10,000–20,000RMB	3.9	5.0	0.0		3.0	0.0		5.2	0.0		6.7	0.0	
>20,000 RMB	1.3	1.3	0.0		0.0	0.0		0.0	0.0		1.3	0.0	
Children under 16 years old (%)	55.5	59.2	44.1	0.026 **	58.2	48.6	0.057 *	68.1	47.8	0.063 *	62.7	35.4	0.041 **
Car ownership (%)	43.8	55.5	28.0	0.016 **	49.4	30.4	0.052 *	53.2	31.5	0.013 **	63.3	24.2	0.021 **
Job–housing distance (km)	5.6	7.5	3.1	0.034 **	7.3	2.6	0.046 **	7.9	3.2	0.034 **	8.3	2.7	0.027 **

Notes: * Significant at the 0.10 level. ** Significant at the 0.05 level. *** Significant at the 0.01 level.

2.2. Methods and Measures

First, based on the activity location, activity type, and activity duration information from the activity diary data, we used 3D geospatial visualization (space–time path) and kernel density estimation methods to visualize the daily activity space of different housing groups in the same neighborhood. This helped us intuitively observe the spatial range, temporal intensity, and hot spots of residents' activities. Then, we quantitatively analyzed the overall characteristics of residents' daily activity spaces. T tests between the indicators of different housing groups' activity spaces were used to determine the significance of the differentiations. Subsequently, we used VISUAL-TimePACTS software to visualize the sequence and time rhythm of residents' daily activities conducted within a 1 km radius of each neighborhood to intuitively visualize the role of neighborhood space in the lives of residents with different housing types. Accordingly, we quantitatively described the activity characteristics of residents within the neighborhood area. Afterward, based on the questionnaire information, we calculated the neighborhood interaction and community ties scores of different housing residents. The indicators of all the variables are illustrated below. Furthermore, we used a multigroup structural equation model to explore the relationships among residents' spatiotemporal behavior characteristics, neighborhood interaction, and community ties. This modeling method is also helpful for determining whether these relationships are heterogeneous across housing groups.

In terms of the indicators of residents' overall activity spaces, we referred to the indicators for studying activity-space-based social segregation that were proposed by Wang and Li [52]. We compared the overall characteristics of residents' daily activity spaces across housing groups in this study from the following three indicators: extensity, intensity, and diversity. The extensity of a resident's activity space is measured by the area of the 95% standard deviational ellipses based on the activity diary data [53]. The intensity of a resident's activity space is measured by the total time spent on out-of-home activities on the diary day and the total time spent on out-of-home nonwork activities on the diary day. The diversity indicator is measured by residents' out-of-home destinations.

We defined the neighborhood area as the 15 min life circle area of each neighborhood, considering that people's daily activities cannot be divided according to the administrative boundaries of their neighborhoods [54,55]. The scope of the 15 min neighborhood life circle is a 15 min (approximately 1 km) walk from the neighborhood gate along the road [56]. Then, we calculated the proportion of overlapping spatial ranges of the neighborhood area and each resident's activity space and obtained the ASN indicator, which refers to the ratio of neighborhood space to individual daily activity space. Similarly, based on the detailed activity diary records, we calculated the time duration that residents spend within the neighborhood area (except home) and further calculated the ratio of residents' activity time within the neighborhood area to their total out-of-home activity time as the ATN indicator. This indicator refers to the time investment that residents spend in the neighborhood area. Furthermore, we counted the number of types of activities that residents conducted within the neighborhood area (NTN) as the indicator of the diversity dimension of neighborhood activities. In addition, according to existing research, most residents' daily activities are systematic and well-projected [57,58]. Residents' daily activities usually have significant variations between weekdays and weekends, while the changes within weekdays and weekends are relatively small [59]. Therefore, we calculated the above indicators for weekdays and weekends to comprehensively understand the daily lives of residents and their related social impacts.

For the measurement of neighborhood interaction, referring to previous studies [60,61], we employed 5 items to capture this variable. The items include "say hello when meeting", "door-to-door communication", "having dinner together", "exercising together" and "helping each other (e.g., sending and receiving express delivery, taking care of children)". Response options ranged from 0 (never) to 5 (very often). We took the mean of all 5 items as the score for the frequency level of neighborhood interaction of a respondent. Higher scores indicated a higher level of neighborhood interaction.

Individuals' community ties are the dependent variable in this study. Based on the literature [8,10,11], we measured this variable using three indicators: common value, mutual trust, and willingness to assist each other. In the questionnaire of our survey, the respondents were required to rate the following statements on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating stronger community ties. The three statements were as follows: (1) My neighbors and I share common values; (2) My neighbors and I trust each other; (3) If we encounter difficulties, my neighbors and I will help each other. After obtaining the scores of the above indicators, we used the *t* test method to examine the differences between different housing groups.

3. Results

3.1. Segregation of Overall Daily Activity Space

The space–time paths of residents with different housing are shown in Figure 4. The X–Y coordinate represents the latitude and longitude, respectively, and the Z-axis represents the time of one day. Different types of daily activities are represented by different colors in the figure, where activities related to work are depicted by red lines, shopping activities by green lines, and leisure activities by blue lines. In addition, the gray three-dimensional prism represents the scope of the neighborhood area. Kernel density estimation of different types of activities was also used to help identify the extensity and intensity characteristics of activity-space-based segregation of different housing groups (see Figure 5). The Second and Third Ring Roads are highlighted by thicker lines for reference. The quantitative analysis results of residents' overall daily activity spaces are shown in Table 2.

Table 2. Characteristics of the overall activity spaces of different housing residents.

		Overall		AH		MH		<i>p</i> Value
		Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.	
Weekday	Extensity (km ²)	13.88	27.631	11.64	29.235	15.55	31.957	0.043 **
	Out-of-home activity time (min)	549.67	102.762	525.43	93.034	567.58	111.588	0.049 **
	Out-of-home nonwork activity time (min)	59.97	36.072	39.46	30.330	75.12	40.223	0.036 **
	Out-of-home destinations	1.87	1.765	1.21	1.980	2.05	1.627	0.038 **
Weekend	Extensity (km ²)	8.82	21.862	8.51	20.96	9.05	25.523	0.036 **
	Out-of-home activity time (min)	256.50	220.761	205.54	216.761	296.52	239.255	0.006 ***
	Out-of-home nonwork activity time (min)	210.43	210.65	188.11	208.430	227.97	218.805	0.052 *
	Out-of-home destinations	2.03	1.041	1.93	0.857	2.11	0.815	0.071 *

Notes: * Significant at the 0.10 level. ** significant at the 0.05 level. *** significant at the 0.01 level.

Figures 4 and 5 and Table 2 show that there are significant differences in the daily overall activity space between residents with market housing and those with affordable housing. On both weekdays and weekends, residents with market housing exhibit significantly higher extensity, while affordable-housing residents' activities are primarily limited to the neighborhood area. In terms of the intensity and diversity of residents' activity spaces, market-housing residents spend significantly more time in out-of-home activities and nonwork out-of-home activities and visit more activity destinations.

Specifically, different types of activities have various differentiation characteristics (see Figure 4). Work activities are the primary purpose of out-of-home activities for residents on weekdays, and they play a dominant role in expanding residents' activity spaces. Affordable-housing residents exhibit a more fixed rhythmic pattern of work activities, with most starting at 8 a.m. and ending at 6 p.m. and having a lunch break from 12 p.m. to 2 p.m. Market-housing residents, conversely, have more flexible work schedules, less notable group characteristics, and a shorter lunch break and are more likely to work in the evenings than affordable-housing residents. For the spatial distribution of residents' working activities, residents of affordable housing exhibit stronger features of working near the neighborhood area, while the working space of market housing is more expanded to the inner city. In addition, from the differences of the three case neighborhoods, SXN has the most limited expansion of working activities, while the working activity expansion

of the residents of PSN and HJN is much larger. This may be due to the accessibility of job opportunities near the three neighborhoods, in which SXN has the most urban opportunities nearby, and HJN has the least.

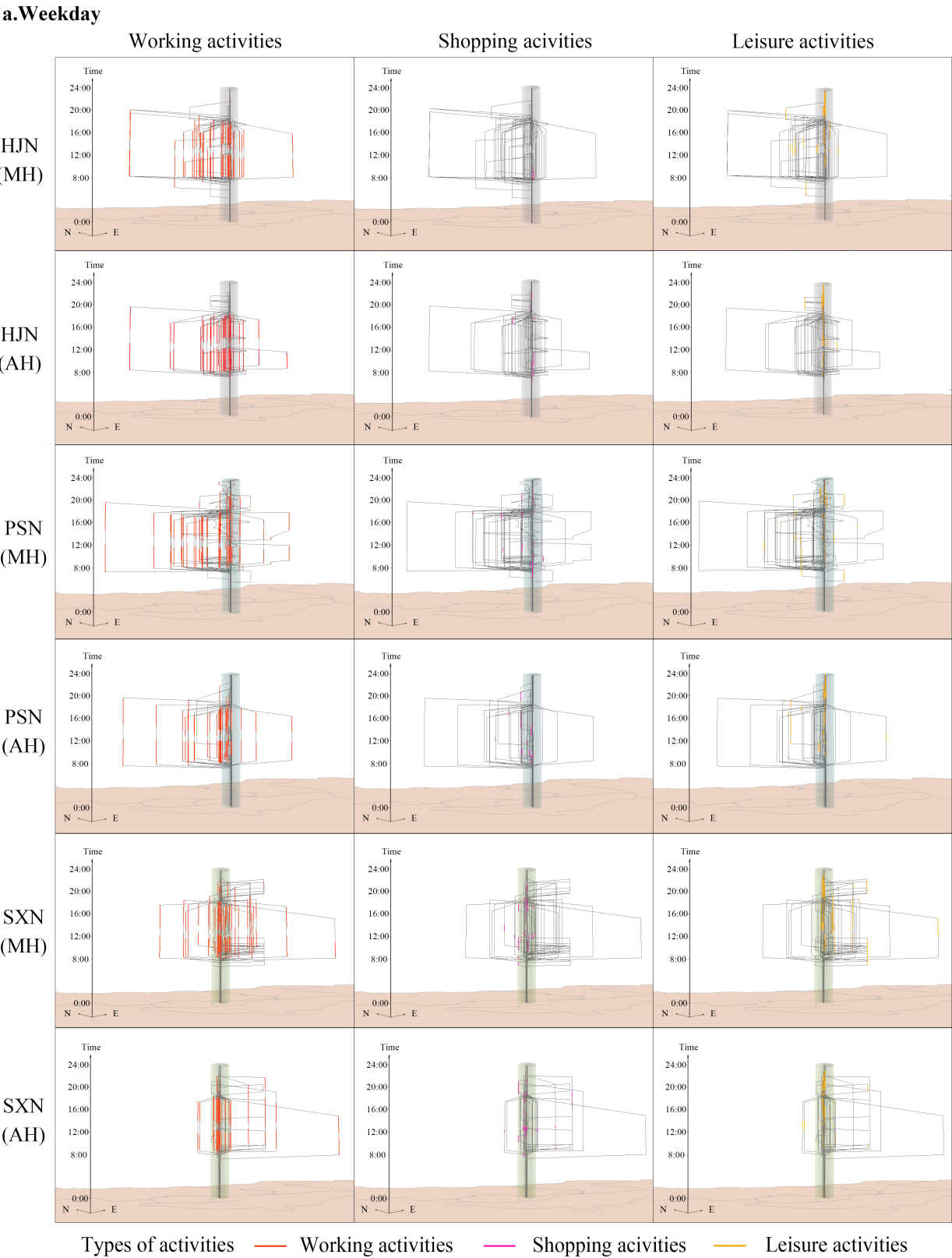


Figure 4. Cont.

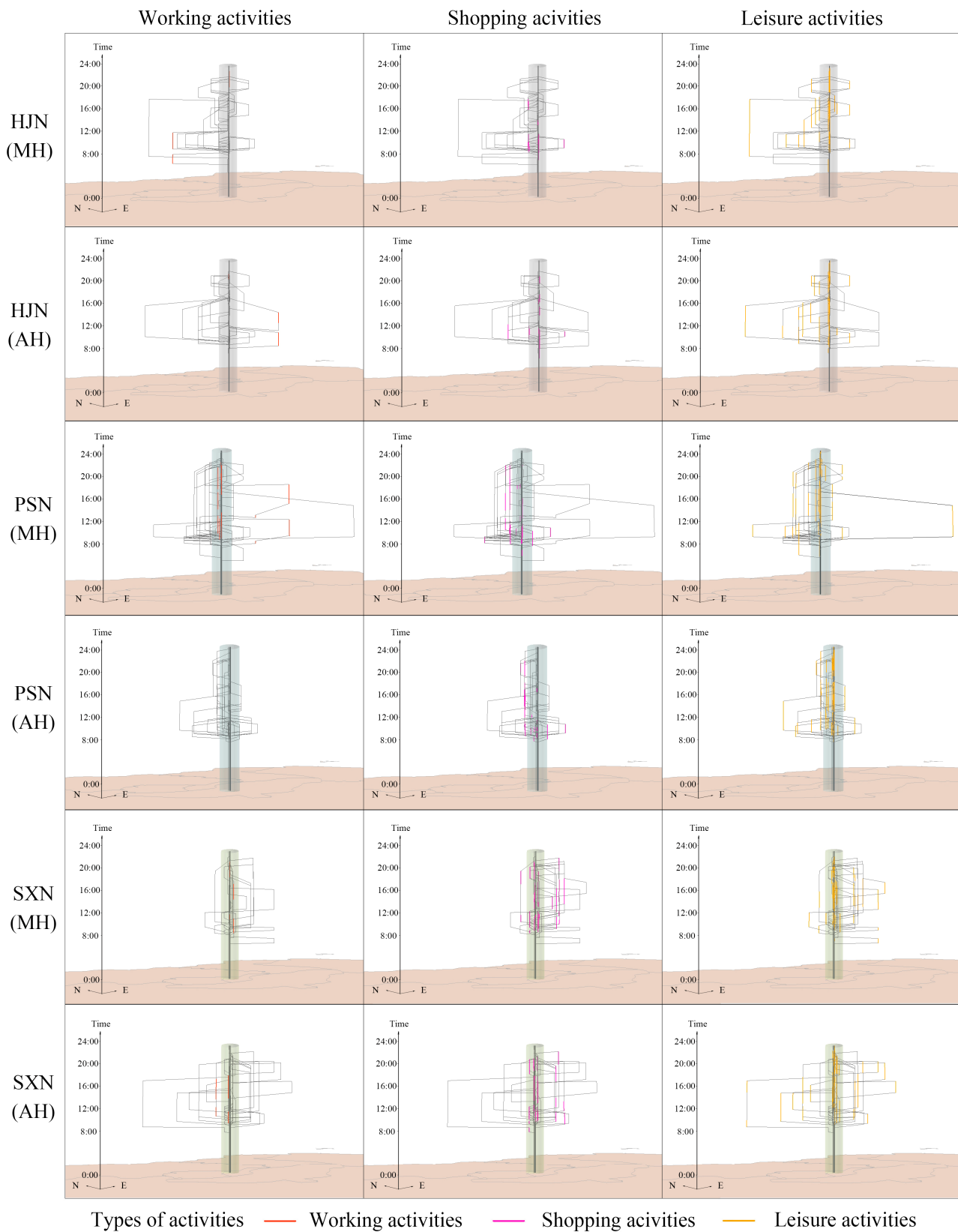
b. Weekend

Figure 4. Space–time paths of residents with different housing types on weekdays and weekends. HJN (Hongjiang neighborhood), PSN (Pushang neighborhood), SXN (Shanghai Xinyuan neighborhood), MH (market-housing residents), AH (affordable-housing residents).

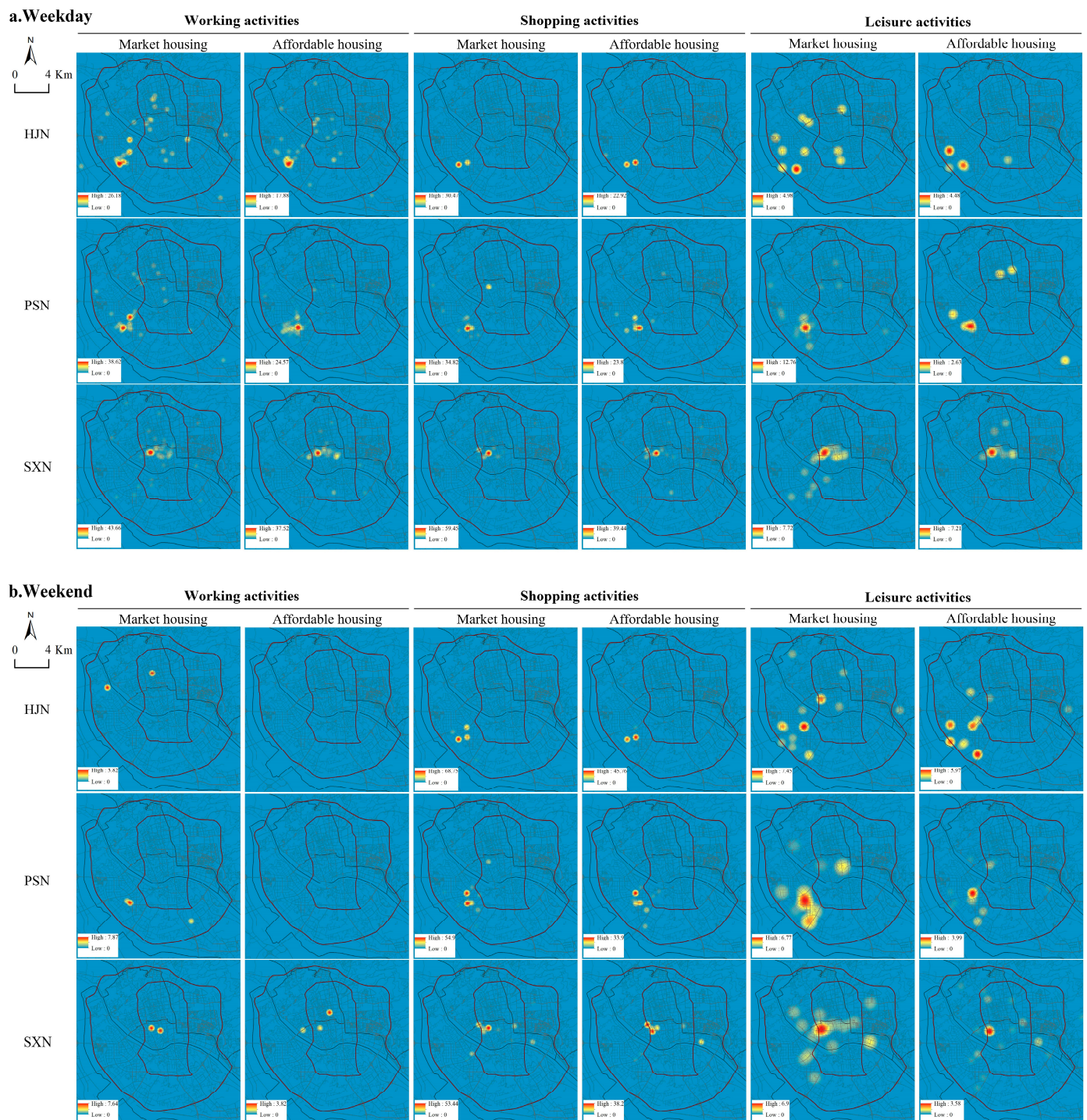


Figure 5. Kernel density estimation results of types of activities of the residents on weekdays and weekends. (Due to the absence of working activities of the respondents of affordable housing in HJN and PSN on the weekend, the activity points in the kernel density map are empty).

Compared with other types of out-of-home activities, shopping activities exhibit a more distinct feature of being distributed near the neighborhood area or at the workplaces on weekdays. This pattern is consistent across the three case neighborhoods. Shopping activities show fragmented and short-duration characteristics. They often occur with temporal continuity with work activities. There is also a small proportion of residents who conduct independent shopping activities on weekdays, and this proportion is higher among affordable-housing residents. These activities occur farther from the neighborhood

and last longer. Shopping activities on weekends are more frequent and longer in duration, and market-housing residents show a more significant spatial expansion in shopping space. Affordable-housing residents tend to shop in areas that align with their budget compared to market-housing residents, which leads to more pronounced shopping activity away from the inner city than market-housing residents in all three neighborhoods.

For leisure activities, on weekdays, the leisure activities of residents with affordable housing mainly occur near residential areas, while the leisure activity spaces of market-housing residents are more expanded, with higher frequency and longer duration. On weekends, leisure activities occur more frequently throughout the day and exhibit greater spatial expansion. Compared to affordable-housing residents, market-housing residents exhibit more spatial expansion, and their high-density activity areas expand from neighborhood areas to inner cities and suburbs.

In all three case study neighborhoods, the daily activities of affordable-housing residents were more concentrated near the neighborhood, while market-housing residents showed a greater tendency to expand, but this differential characteristic is the smallest in the SXN. This indicates that, although the density of urban facilities around the three case neighborhoods is different, residents of different housing types living in the same neighborhood still exhibit segregated patterns in daily overall activity space.

3.2. Segregation of Activities within Neighborhood Area

Mixed-housing neighborhoods should be not only residential spaces but also important carriers for residents' daily activities, thereby promoting the effects of neighborhood interaction and community ties [14]. Based on the information on activity location, activity duration, and activity type from the activity diary data, we calculated the percentage of neighborhood area that overlaps with the daily activity space (ASN), proportion of time spent out-of-home within the neighborhood area (ATN), and number of types of activities conducted within the neighborhood area (NTN). The results are shown in Table 3. All three indicators for affordable-housing residents were significantly higher than those for market-housing residents on both weekdays and weekends. This indicates that residents with affordable housing have more space, time, and activity arrangements in neighborhood areas and rely more on neighborhood space.

Table 3. *t* Test results of activities within neighborhood areas of different housing residents.

		Overall		AH		MH		<i>p</i> Value
		Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.	
Weekday	ASN	9.52	0.294	13.25	0.337	7.31	0.252	0.044 **
	ATN	4.21	0.191	5.11	0.219	3.52	0.166	0.039 **
	NTN	1.64	0.983	1.78	1.029	1.14	0.935	0.131
Weekend	ASN	31.57	0.245	39.02	0.278	25.72	0.202	0.007 ***
	ATN	28.19	0.131	32.83	0.133	24.57	0.121	0.037 **
	NTN	1.64	0.983	1.78	1.029	1.54	0.935	0.135

Notes: ** Significant at the 0.05 level. *** Significant at the 0.01 level.

Furthermore, by visualizing activity diaries in VISUAL-TimePacTS software, we analyzed the activity types, sequence, and rhythm of residents' activities in the neighborhood area (see Figure 6). The left side of each small chart represents the activity sequence of residents, and the line chart on the right represents the time rhythm. In the activity sequence diagram, the vertical axis represents the time of the day from 0:00 to 24:00, and each column on the horizontal axis represents a sample. The colored parts marked on the pillars represent residents' activities in the neighborhood area, and different colors represent different types of activities. The gray areas indicate that residents are currently in other locations besides the neighborhood area, such as outside the neighborhood area or within their own homes. Each activity is arranged in chronological order, forming a sequence of residents' activities. The horizontal axis of the time rhythm chart on the right

represents the proportion of samples, while the vertical axis represents the period from 0:00 to 24:00. The broken line represents the proportion of samples undergoing a certain type of activity at different times.

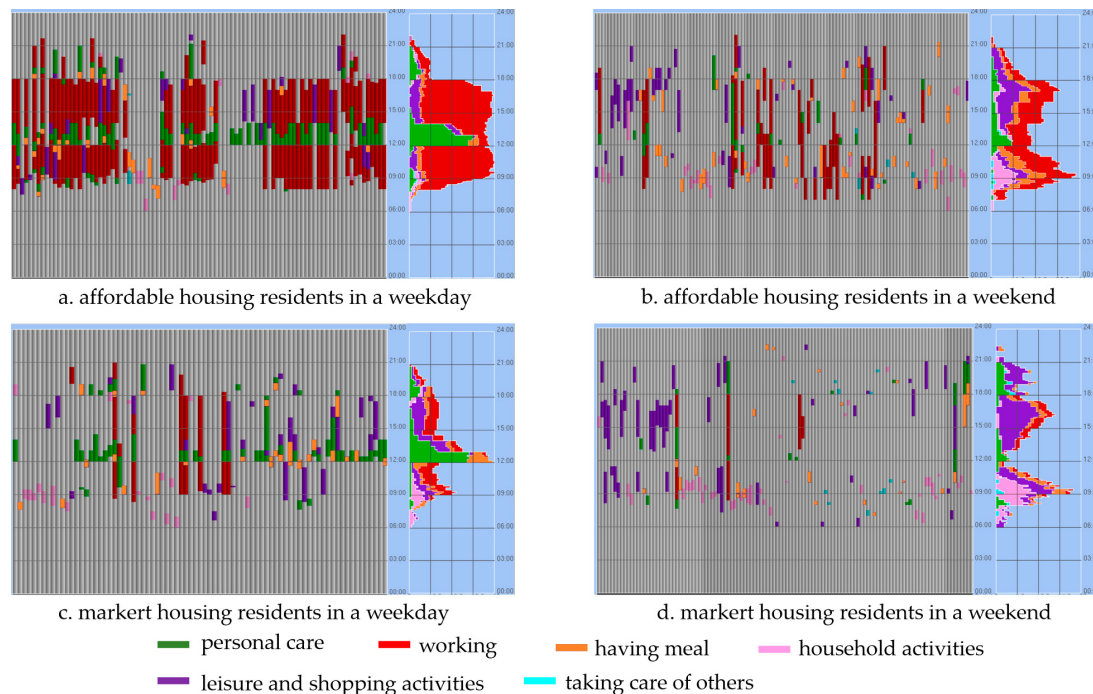


Figure 6. Sequence and rhythm of activities in neighborhood areas of different housing groups.

Figure 6 shows that, on weekdays, residents with affordable housing have more activities in neighborhood areas during the daytime. A large proportion of residents with affordable housing work in neighborhood areas, forming two peaks of work activity at approximately 10 a.m. and 4 p.m., respectively. Conversely, market-housing residents have fewer activities in neighborhood areas, with the main types of activities being household activities, personal care, and leisure and shopping activities. Compared to weekdays, residents' activities in neighborhood areas outside their homes are reduced on weekends. Notably, market-housing residents have fewer and scattered activities in neighborhood areas.

The analysis of activities within neighborhood areas further demonstrates the dependence of the daily activities of affordable-housing residents on the neighborhood area. On the other hand, it also indicates that, even on weekends, the activities of market-housing residents in the neighborhood area are still relatively low and exhibit a short-term and scattered distribution, indicating that the factors influencing their choices are not only limited by their workplace, but also follow some other factors, such as their socioeconomic attributes and personal preferences.

3.3. Relationships among Residents' Daily Activities, Neighborhood Interactions, and Community Ties

Table 4 shows the scoring values and *t* test results of neighborhood interaction and community ties between residents with different housing types. From the perspective of neighborhood interaction, residents with affordable housing have a higher frequency. There is no significant difference in “say hello when meeting” between residents with different housing types. In terms of door-to-door communication, exercising together, and helping each other, the frequency of neighborhood interaction of residents with affordable housing is much higher than that of residents with market housing. However, in deeper neighborhood interactions, such as having dinner together, residents of different housing groups both showed low frequency scores. These results indicate that, for residents with market housing, the frequency of neighborhood interaction is much lower.

In terms of community ties, residents with affordable housing have higher scores than market-housing residents in mutual trust and willingness to assist each other. However, in terms of common value, both housing groups show lower scores than the other two indicators, and there is no significant difference between the two groups.

Table 4. *t* Test results of neighborhood interaction and community ties of residents in different housing types.

	Overall		AH		MH		<i>p</i> Value
	Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.	
Neighborhood interaction	2.36	0.881	2.78	0.902	1.95	0.864	0.041 **
say hello when meeting	4.15	0.721	4.25	0.671	4.11	0.876	0.105
door-to-door communication	3.07	0.572	3.56	0.656	2.17	0.421	0.072 *
exercise together	3.31	0.431	3.78	0.412	3.05	0.562	0.043 **
help each other	3.29	0.475	3.76	0.323	3.06	0.795	0.035 **
having dinner together	2.25	0.423	2.67	0.519	1.89	0.376	0.104
Community ties	3.27	0.635	3.61	0.621	3.17	0.634	0.007 ***
mutual trust	3.42	0.745	3.75	0.721	3.08	0.751	0.005 ***
willingness to assist each other	3.83	0.808	4.05	0.776	3.59	0.819	0.026 **
common value	2.85	0.814	3.04	0.785	2.65	0.832	0.106

Notes: * Significant at the 0.10 level. ** Significant at the 0.05 level. *** Significant at the 0.01 level.

Furthermore, based on the previous literature review and our research framework, to deeply analyze the social effects of the spatiotemporal behavior segregation of different housing residents in mixed-housing neighborhoods, we used a multigroup structural equation model to analyze the relationships among residents' daily activities, neighborhood interaction, and community ties. The results of the structural model indicated the acceptable model fit (see Table 5). Table 6 shows that the causal relationships hypothesized in the framework (Figure 1) were confirmed by the model results (the measurement invariance results are shown in Appendix A, Table A1). As shown in Table 6, the proportion of out-of-home time spent in the neighborhood area (ATN), percentage of daily activity space that overlaps with the neighborhood area (ASN), and number of types of activities conducted within the neighborhood (NTN) all had a significant positive impact on residents' neighborhood interactions (NIs). A similar effect was also found for the influence of NI on community ties (CT). Regarding the influence of residents' spatiotemporal behaviors on CT, the associations with ATN, ASN, and NTN were all positively significant at the 5% level. Therefore, more time spent in the neighborhood area, high percentages of daily activity space that overlaps with the neighborhood area, and various types of activities in the neighborhood increased CT; moreover, these effects were enhanced by increasing NIs.

Then, we conducted multigroup comparison models. After constructing the unconstrained model, the fully constrained models, and the partially constrained models, we finally obtained the final models. The constraints on the path coefficients (ASN→NI, ATN→NI, NTN→NI) in the final model for weekdays were released. This indicates that the differences in these path coefficients across housing groups are not significant. The goodness-of-fit indicators all fit the reference value (see Table 5).

Table 5. Goodness-of-fit statistics of the models and reference values.

	Reference Value	Structural Model	Weekday Model	Weekend Model
χ^2		1469.88	1578.32	1568.41
Df		268	254	237
CFI	>0.90	0.923	0.925	0.921
RMSEA	<0.05	0.046	0.029	0.045
SRMR	<0.05	0.039	0.037	0.025
TLI	>0.90	0.919	0.919	0.907
<i>p</i> -value	>0.05	0.075	0.082	0.061

Notes: CFI (comparative fit index), RMSEA (root mean square error of approximation), SRMR (standardized root mean square residual), TLI (Tucker–Lewis index).

Table 6. The direct effects between endogenous variables in the structural model.

Hypothesis	Path	β	<i>p</i> Value	Supported
H1	ASN-->NI	0.725	0.037	Yes
H2	ATN-->NI	0.538	0.029	Yes
H3	NTN-->NI	0.293	0.035	Yes
H4	NI-->CT	0.164	0.041	Yes
H5	ASN-->CT	0.451	0.032	Yes
H6	ATN-->CT	0.504	0.020	Yes
H7	NTN-->CT	0.436	0.013	Yes

Notes: ASN (the percentage of neighborhood area that overlaps with the daily activity space), ATN (the proportion of time spent out-of-home within the neighborhood area), NTN (the number of types of activities conducted within the neighborhood area), NI (neighborhood interaction), CT (community ties).

The direct effects among endogenous variables in the models are shown in Figure 7. Figure 7 indicates that increasing the ASN, ATN, and NTN in the neighborhood area, whether on weekdays or weekends, has a significant positive impact on CT. At the same time, NI serves as a linkage between residents' spatiotemporal behaviors and CT. Furthermore, the model results show that there is significant heterogeneity in the immediate effects among residents' spatiotemporal behaviors, NIs, and CT between residents with different housing types. Compared to affordable-housing residents, increasing the ASN, ATN, and NTN of market-housing residents on weekends will significantly further enhance NI and CT. However, on weekdays, the relationships among ASN, ATN, NTN, and NI were not significantly different across housing groups. This indicates that market-housing residents are more sensitive to the path of increasing NI and CT by increasing ASN, ATN, and NTN, especially during weekends. Therefore, increasing behavioral guidance for market-housing residents and encouraging them to engage in more daily activities around the neighborhood area will help to generate the positive effects of community ties.

The direct effects of exogenous variables on endogenous variables in the models are shown in Table 7. As shown in the table, compared with market-housing residents, affordable-housing residents have a significantly larger ASN, ATN, and NTN on both weekdays and weekends. This illustrates that, although residents with affordable housing and market housing reside in the same neighborhood, there are significant differences in their daily activity arrangements and activities allocated in the neighborhood. Specifically, residents of affordable housing rely more on neighborhood areas for their daily activities. Meanwhile, consistent with the research hypothesis of this study, the NI and CT of affordable-housing residents are also significantly higher than those of market-housing residents. This indicates that groups with more activities in neighborhood areas have significantly higher NI and CT than other groups. In addition to housing type, gender, age, marriage status, monthly income, hukou, employment status, length of residence, and job-housing distance all have significant impacts on endogenous variables. Compared to men, women have more time allocation and overlapping activity space within the neighborhood area, as well as more types of activities in the neighborhood. Their NI and CT are also significantly higher than those of men. The impacts of age and marital status on endogenous variables are similar to those of gender. In terms of monthly income, as residents' income increases, their ASN, ATN, and NTN significantly decrease, whether on weekdays or weekends. However, the changes in NI and CT were not significant. Compared with local residents, the NI and CT scores of immigrants are significantly lower. Part-time or unemployed residents have more spatiotemporal activities in the neighborhoods. Length of residence also has a significant positive impact on NI. Job-housing distance has negative impacts on all the endogenous variables.

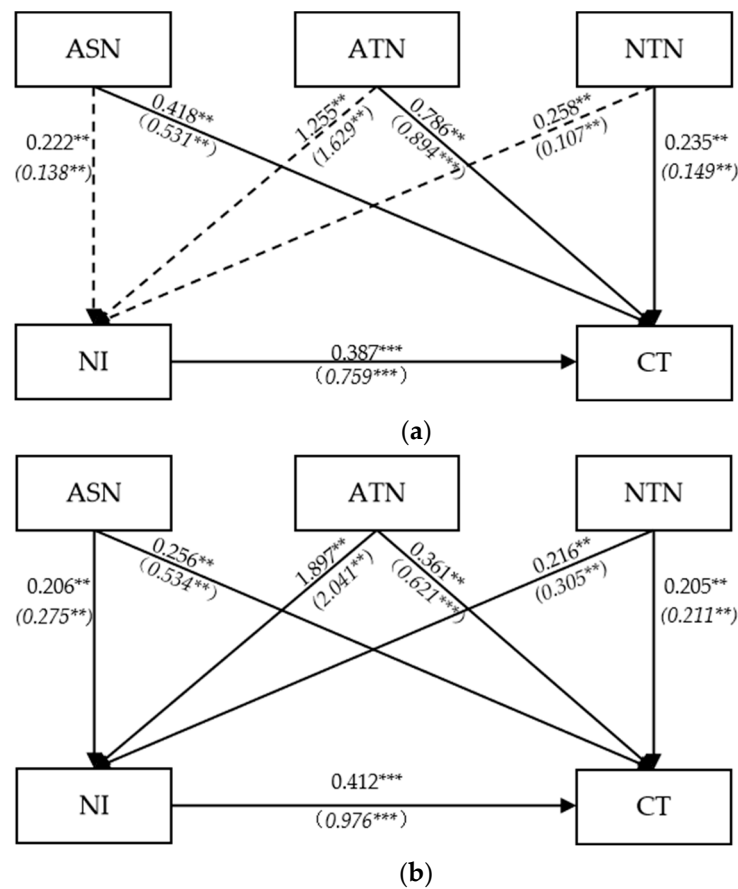


Figure 7. Results of grouping comparison models. (a) The direct effects between endogenous variables in the weekday SEM model; (b) The direct effects between endogenous variables in the weekend SEM model. Notes: ** Significant at the 0.01 level. *** Significant at the 0.001 level. β for the market housing group is in parentheses. ASN (the percentage of neighborhood area that overlaps with the daily activity space), ATN (the proportion of time spent out-of-home within the neighborhood area), NTN (the number of types of activities conducted within the neighborhood area), NI (neighborhood interaction), CT (community ties).

Table 7. The direct effects of exogenous variables on endogenous variables.

	ASN	ATN	Weekday Model NTN	NI	CT	ASN	ATN	Weekend Model NTN	NI	CT
Housing Type										
Affordable housing	0.041 **	0.072 **	0.362 *	0.419 **	0.513 *	0.052 **	0.083 **	0.402 *	0.528 **	0.405 *
Market housing	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Gender										
Female	0.026 *	0.085 *	0.571 *	0.562 *	0.118 *	0.105	0.041 *	0.376 *	0.275 *	0.125 *
Male	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Age	0.106 *	0.163 **	0.952 **	0.681 *	0.142 *	0.115 *	0.206 **	0.762 **	0.572 *	0.117 *
Marriage status										
Married	0.025 *	0.273 **	0.821 *	0.781 *	0.462 *	0.019	0.076	0.857 *	0.829 *	0.327 *
Other status	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Monthly income	−0.026 *	−0.275 *	−0.796 **	−0.692	−0.576	−0.032 *	−0.057 *	−0.752 **	−0.12	−0.316
Hukou										
Locals	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Migrants	−0.015	−0.172 *	−0.619	−0.596 *	−0.405 *	−0.008	−0.003	−0.562	−0.482 *	−0.01 **
Employment										
Full time	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Part time or unemployed	0.072 *	0.077 *	0.652 *	0.519 *	0.175	0.081 *	0.087 *	0.723 *	0.552 *	0.177
Length of residence	0.011	0.079	0.795	0.792 *	0.309 *	0.02	0.019	0.581	0.571	0.411 *
Job–housing distance	−0.056 *	−0.108 **	−0.541 *	−0.276 *	−0.202	−0.032 *	−0.092 *	−0.621 *	−0.317 *	−0.256 *

Notes: * Significant at the 0.10 level. ** Significant at the 0.05 level. ASN (the percentage of neighborhood area that overlaps with the daily activity space), ATN (the proportion of time spent out-of-home within the neighborhood area), NTN (the number of types of activities conducted within the neighborhood area), NI (neighborhood interaction), CT (community ties).

4. Discussion

Our study analyzed the microsegregation of the spatiotemporal behavior of residents with different housing in mixed-housing neighborhoods, as well as the relationships among residents' behaviors, neighborhood interactions, and community ties. We contribute to the field of microsegregation research by identifying microsegregation issues within neighborhoods from the perspective of the spatiotemporal behavior of different housing groups. At the same time, we investigated the relationships among residents' daily activities, neighborhood interactions, and community ties. Based on the results of this study, decision-makers and urban planners can gain a deeper understanding of the microsegregation issues within mixed-housing neighborhoods, which is helpful for developing better measures and policy tools to promote community ties. Optimizing land allocation and reasonably adjusting land-use functions may be helpful for meeting the living needs of different housing groups, providing more opportunities to conduct neighborhood interactions and strengthening community ties. Our main findings and policy implications are illustrated below.

One major finding of our study is the salient spatiotemporal-behavior-based social segregation for residents with different types of housing in mixed-housing neighborhoods. Specifically, residents with affordable housing have a greater ASN and ATN, even though the size of their daily overall activity space is much smaller than that of market-housing residents and their total out-of-home activity time is much less than that of market-housing residents. Conversely, the indicator of NTN was not significantly different between the two groups. This characteristic has been manifested both on weekdays and weekends. This indicates that, although residents with affordable housing have more ATN and ASN, the types of activities for residents with affordable housing in the neighborhood area are not more diverse. They spent most of their time in neighborhood areas working and meeting their basic living needs. This can be explained by their fewer fulltime jobs, shorter job-housing distance, and lower car ownership. For market-housing residents, a longer commuting distance is a factor that affects their activity allocation in neighborhood areas. However, on weekends, they still have fewer activities within neighborhood areas, indicating that they are more inclined to engage in nonwork activities outside neighborhood areas. This may be related to their consumption level and lifestyles.

These results are consistent with previous findings, such as those by Ta et al. [62] and Arthurson [63], which indicated that, although mixed-housing neighborhood policies have mixed residential spaces for groups with different socioeconomic attributes, different housing groups are still segregated in terms of the allocation of daily activity space and time. This is very detrimental to achieving the policy goals of mixed-housing neighborhoods because it reduces the possibility of cross-group interactions. In this study, SXN enjoys superior locational conditions, a more convenient living environment, and greater accessibility to urban opportunities compared to other neighborhoods, leading residents to predominantly concentrate their daily activities around the neighborhood, particularly shopping and leisure pursuits. This fosters positive community ties among residents of different housing types, with reduced disparities in activity patterns between market- and affordable-housing residents within SXN. Therefore, adjusting the land-use structure and improving the quality of urban facilities around mixed-housing neighborhoods may encourage market-housing residents to shrink their daily activity space and time allocation toward the neighborhood area. On the other hand, although affordable-housing residents have more overlapping activity space and time allocation within neighborhood areas, most of these activities are work activities. Therefore, optimizing the public transportation system around the mixed-housing neighborhood may make it more convenient for affordable-housing residents to carry out diverse nonwork activities near the neighborhood.

Second, our study verified the link between residents' spatiotemporal behaviors and community ties and the linkage effect of neighborhood interaction in the relationships. The more residents' activity spaces overlap with the neighborhood area, the more out-of-home time they spend within the neighborhood, and the more types of activities are conducted within the neighborhood area, the stronger their community ties are. Residents who have

more opportunities to perform activities in the neighborhood area will be more likely to interact with their neighbors, which may enhance their community ties in the long term. Again, this finding supports that residents with market housing are not only exhausted by weekday activities and trips further away from the neighborhood area but also estranged from their neighbors and neighborhood environment, which might contribute to their lack of community ties. Therefore, one possible strategy is to establish neighborhood areas with a strong job–housing balance. If more job opportunities matching residents' skills are provided in or near the neighborhood, the space–time constraints from long-distance commuting could be somewhat reduced, leaving residents more time to interact with their neighbors and build strong community ties.

Third, we found heterogeneity effects of the relationships among residents' spatiotemporal behaviors, neighborhood interactions, and community ties caused by housing type. Through the multigroup structural equation modeling method, we found that market-housing residents are more sensitive to the relationships among individual temporal spatial behavior, neighborhood interaction, and community ties. That is, increasing behavioral guidance for market-housing residents and encouraging them to engage in more daily activities around the neighborhood area will help generate the positive effects of community ties. For affordable-housing residents, although their low socioeconomic status and limited means of transportation anchor their daily activity space around the neighborhood area, they have increased their dependence on the local neighborhood and thus increased the opportunities for neighborhood interaction. This once again indicates that the localization of daily activity spaces helps promote community ties.

Furthermore, our findings also reflect the recent argument on the discordance between the neighborhood effect and contextual uncertainty. As Kwan [64] suggested, “how a person perceives, understands, and reacts to specific environmental factors could be peculiar and person specific. Because the same environmental factors might lead to different behaviors or outcomes due to person-specific attributes, this is a major source of contextual uncertainty in the neighborhood effects literature”. As cities in China learn from the mixed-housing policies implemented in developed countries to accommodate residents of diverse socioeconomic backgrounds in the same neighborhood, caution is needed to investigate whether living nearby can effectively promote the interaction of different social groups and improve community ties. Our findings show that residents living in the same neighborhood have segregated daily activity spaces and activities within neighborhood areas, and those residents who perform most daily activities outside the neighborhood area tend to have low community ties. Therefore, policymakers and urban planners should account for residents' daily mobility and attempt to reduce their space–time constraints. It is our belief that common space–time opportunities for different social groups are a prerequisite for their interactions and for enhancing community ties.

5. Conclusions

This study aimed to identify microsegregation in mixed-housing neighborhoods from the perspective of the spatiotemporal behaviors of different housing groups. It further explored the relationships among residents' daily activities, neighborhood interactions, and community ties. Through 3D geovisualization, descriptive analysis, and multigroup structural equation modeling (SEM) methods, this study revealed that the segregation of spatiotemporal behavior exists across housing groups in mixed-housing neighborhoods. Additionally, individual neighborhood activities were found to have positive effects on community ties. Neighborhood interaction plays a crucial role in linking individual spatiotemporal behavior and community ties. These findings could have significant implications for planning neighborhoods and urban land use.

Some limitations should be borne in mind when interpreting our findings. Firstly, it is essential to acknowledge that the selected case neighborhoods in our study solely represent mixed-housing neighborhoods formed under the influence of government interventions. Hence, our findings are specific to this particular type of mixed-housing neighborhood.

Since our study did not encompass other types of mixed neighborhoods or market-based residential neighborhoods, the ability to directly compare different types of neighborhoods and the broader applicability of our conclusions are limited. If more different types of neighborhood survey data can be included in future research, it may help to draw more widely applicable conclusions. Secondly, the feedback loop of community ties on residents' neighborhood behaviors has not been tested in this study. Future research should conduct more investigations to test the two-way relationships. Finally, we are unable to identify long-term changes in residents' community ties within the residential neighborhood, which are closely connected to the life course and relocation history of various social groups. To provide more robust and relevant evidence on the creation of strong community ties, qualitative studies and longitudinal cohort studies are required.

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Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Measurement invariance results.

	SB- χ^2	$\Delta\chi^2$	Df	Δdf	CFI	RMSEA	SRMR	p Value
Configural invariance	1495.45	--	226	--	0.913	0.051	0.066	--
Weak invariance	1537.56	42.11	255	29	0.927	0.054	0.068	0.329
Strong invariance	1559.08	21.52	282	27	0.912	0.056	0.073	0.218
Strict invariance	1576.33	17.25	307	25	0.925	0.052	0.076	0.172

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