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Daily activity space and exposure: a comparative study of Hong Kong's public and private housing residents' segregation in daily life

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Abstract

Differences in individuals' exposure to social/physical environment in daily life or activity-space segregation have aroused renewed interests in socio-spatial separation in geography and urban studies. However, there are not many empirical studies that comprehensively assess activity-space segregation perhaps due to the scarcity of detailed data to define and characterize activity space. This paper aims to help fill in this gap by contributing an empirical study in Hong Kong. We compare the daily life experiences of public and private housing residents in terms of activity space and exposure to people in their daily life. We find that inhabitants of public housing in Hong Kong are disadvantaged in many ways. Public housing residents' lower socio-economic status, smaller homes, and lower car ownership distinguish them from inhabitants of private housing. We also find that the activity spaces of these residents are not necessarily smaller than those of private housing residents. Public housing residents in fact have more extensive activity spaces and spend more time out of the home. However, their activity spaces are socio-economically different from those of private housing residents. They are more likely exposed to people similar to themselves than private housing residents. This study offers some important empirical evidence on activity-space segregation as well as improves the understanding about socio-spatial distance between public and private housing residents of Hong Kong.

Keywords: Segregation, Exposure, Activity space, Public housing, Private housing, Hong Kong

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Introduction

Socio-spatial segregation has emerged from time to time as a hot topic of research for decades. Conventional studies have focused on residential segregation of ethnical/social groups (Logan et al., 2004; Massey & Denton, 1987). Recently it has been argued that segregation may extend from residential place to a variety of other places where people spend time and perform daily activities such as working, shopping and worshipping, etc. (Kwan 2012; Krivo, et al, 2013)), in other words, the divide between social classes may not only exist in the form of spatial separation of residences but may also manifest itself in different daily life experiences and trajectories (Atkinson and Flint, 2004; Schnell and Yoav, 2001; Wang et al., 2012; Krivo, et al., 2013). Alternatively, it can equally be contended that people may be less segregated at places other than residence because the social environment of the other places may be more heterogeneous than that of residential neighborhood. A number of studies have reported that there are only weak association between the social/physical environments of residential neighborhoods and that of places where work, shopping, recreation and other activities are conducted in daily life (Kestens et al, 2010; Zenk et al, 2011; Jones and Pebley, 2014). It has been increasingly recognized that a fuller understanding of urban segregation requires critical analyses of not only the socio-demographic characters of individuals' residential neighborhoods, but also the types of social environments and individuals with whom they contact when conducting daily activities. It is argued that segregation studies should be extended from residential segregation to segregation of social groups in space and time in general or activity-space segregation (Schnell and Yoav, 2001; Atkinson and Flint, 2004; Ellis, et al, 2004; Wong and Shaw, 2011; Wang et al, 2012; Palmer, 2012).

Research on activity space-based segregation is at an infant stage. As it will be argued in the next section, the existing empirical studies examine only certain aspects of activity-space segregation, perhaps due to the unavailability of relevant data that can be used to identify the actual activity- space and socio-economic compositions of activity space. To help fill in this research gap, this study will use first-hand activity-dairy data to identify individuals' actual activity space and second-hand population census data to characterize the social environments of activity space to examine the activity-space segregation of Hong Kong's public and private housing residents, covering both residential and non-residential environments where daily activities are conducted. This will allow us to comprehensively assess individuals' activity-space segregation in terms of not only features of activity space, but also opportunities of exposure to a variety of social environments in daily life.

The study will also shed light on the segregation between private and public housing residents. Though the public housing sector is relatively small in many cities in the world, it hosts almost half of the population in Hong Kong (Wang and Lin, 2013). According to Chiu (2003), the average living space of public housing tenants in Hong Kong was only

8.6 square meters per person, just over half the space of private housing residents (16.4 square meters). Compared to private homeowners and renters, public housing residents are significantly poorer and view themselves as disadvantaged and having a lower social status, even though they are much less likely to be unemployed or on welfare than those trapped in public housing projects in the United States (Forrest & Wu, 2014). It will be interesting to examine if private and public housing residents are segregated in daily life.

This paper is structured as follows. The next section reviews the literature on residential segregation and recent studies on segregation in daily life, which provides the theoretical background for the present study. The third section explains the measurement framework of socio-spatial segregation in daily life experience. The fourth section presents the data and case. The empirical findings on activity space segregation of public and private housing residents are presented and discussed in the fifth section. The last section summarizes and discusses the major research findings.

Literature review

Due to the deep-rooted racial divisions in Western, especially American cities, the spatial separation between different ethnic groups in urban neighborhoods has been a major focus of socio-spatial segregation studies (Smets & Salman, 2008). Ethnic residential segregation has long been regarded as a crucial social problem and has been continuously examined by scholars and practitioners (Logan et al., 2004; Massey & Denton, 1987). Though some studies have reported a decline of black-white segregation in American cities, new patterns of ethnic residential segregation have formed, such as Hispanic and Asian segregation (Logan et al., 2004). Moreover, segregation issues have gained increasing attention in the other parts of the world, including Canada (Bauder & Sharpe, 2002; Myles & Hou, 2004), Europe (Musterd, 2005; Simpson, 2004; Manley & van Ham, 2011; Bolt et al., 2012) and the developing, mostly postcolonial, countries and regions (Forrest et al., 2004; Delang & Lung, 2010). Along with a growing income inequality in the United States, researchers have begun to be concerned about the rising socio-economic segregation and its effects on education, civic participation and health (Mayer, 2002). Jargowsky (1996) showed a growing trend of economic segregation within ethnic groups.

Earlier studies of segregation have focused on the residential neighborhood as the main context. Ellis et al. (2004) argue that by ignoring segregation in other socio-geographical contexts, researchers may produce biased or even misleading assessments of the overall levels of segregation in a society. The limitation of this approach has been highlighted by the increasingly important role that transportation and mobility play in modern urban life

(Van Kempen & Wissink, 2014). Mobility and the conduct of regular daily activities provide people opportunities of exposure to social environment that is different from that of residential neighborhoods. A substantial proportion of individuals' time is spent at places other than residential neighborhoods for work, shopping, recreation, and other daily activities and the socio-economic characteristics of these places may be different from that of residential neighborhoods. A number of studies have investigated the similarities/dissimilarities between the socio-economic characteristics of activity locations and that of residential areas. Zenk et al (2011) find that environmental features of residential neighborhoods and activity locations are weakly associated. Kestens et al (2010) report that individuals' exposure to foodscape in places where daily activities are conducted differs from that in residential neighborhood; Shareck et al. (2014) examine the similarity in deprivation level in the residential area and non-residential activity space and find only low to medium correlations between the two. Jones and Pebley (2014) compare the socio-economic characteristics of individuals' activity space with those of their residential neighborhoods and again find weak association between these two. The findings of these studies justify the claim that individuals' exposures to physical and social environments in the residential and non-residential contexts are different. The experiences at the non-residential contexts may mitigate, flatten or exacerbate the segregation at residential neighborhoods (Kriwo et al., 2013).

Thus, segregation studies centered on where people reside may fail to reveal the full spectrum of segregation that individuals may experience in daily life. Instead, segregation studies should pay more attention to the activities and experiences beyond the residential neighborhoods and examine the "ways of using space in the constitution of personal and social identities, rather than the residential agglomeration of social groups in neutral and static space" (Schnell and Yoav, 2001, p. 622). The argument has been made by many studies that residential segregation should be extended to the so-called 'activity-space segregation', which is referred to the separation of social groups in space and time of daily life (Wong and Shaw, 2011; Palmer, 2012; Wang et al, 2012). Activity space is usually defined as the part of the environment a person visits and utilizes in performing day-to-day activities (Schönfelder and Axhausen, 2003). An increasing number of studies have been conducted in the past few years to empirically investigate activity-space segregation. Two major streams of studies can be identified:

The first stream inherits from the conventional residential segregation studies focusing on the exposure dimension of segregation (Lieberson, 1981) and emphasizes on the differences between social groups in exposure to social environments or in the potential for encountering and contacting other social groups in activity space. The underlying assumption is that segregation may be reduced or exacerbated if there are more or less interactions between different social groups and the chance of cross-group interaction depends on the presence of people who belong to a different group in one's activity space.

Krivo et al. (2013) investigated the exposure to the social environment of activity space covering the neighborhoods of both residential and locations other than home and work for major activities such as grocery shopping, visiting friends and family, eating at restaurant, etc. (non-residential activity space, or 'non-residential' neighborhoods' by their term. Social environment is assessed by disadvantage levels measured by percentages of joblessness, poverty, female-headed families and others of the neighborhoods. They found a positive association between the disadvantage level of individuals' residential neighborhoods and that of the neighborhoods where they conduct their daily activities. The association is consistent for residents of neighborhoods at different levels of disadvantage and for all racial/ethnic groups. The use of urban space is found to be racialized in the sense that the places where African American and Latinos conduct activities are significantly more disadvantaged than that where whites do even if they are living in economically similar neighborhoods (Krivo et al., 2013). Shareck et al. (2014) compared the exposure to deprivation level (measured by a composite index of education, employment and income) in the residential area and non-residential activity space between individuals of different education groups and found that though less educated respondents lived and conducted activities in more deprived areas than their more educated counterparts, all educational groups experienced more advantaged places than their residential area during the course of their daily activities. Nevertheless, the differences in exposure to deprivation are found to be larger in the non-residential activity space than in the residential area between the least and most educated groups, but smaller between the intermediate and most educated groups (Shareck et al. 2014). Farber, Páez and Morency (2012) study the exposure to each other of native English and French speakers in Montreal by their levels of mobility (measured in terms of the average length of daily trips). They find that mobility contributes positively to the cross-linguistic exposure. While these studies aim to reveal the differences in exposure to the social environment that individuals experience in activity space, they often ignore and fail to account for the variations of individuals' activity spaces, which may show differences in access to resources and opportunities that are the major concern of another major stream of studies.

This second stream of studies focuses on characterizing activity space and comparing activity spaces of social groups observed through GPS tracking or activity diary or travel survey. This group of studies is more concerned about the differences in access to resources and opportunities between social groups and assume that the lack of access to facilities, resources and employment, whether due to concentration of poverty, insufficient physical infrastructure or high travel costs, could deprive the disadvantaged groups of essential services, social support and life opportunities and limit their participation in public life. Characteristics of activity space are assumed to be important indicators of accessibility to resources and opportunities. Kestens et al. (2010) make use of travel survey data to identify activity locations where the foodscape is examined and

compared for different social groups. They find that exposure to foodscape in daily life varies with age and income and exposure to different food sources is higher for people living in low income neighborhoods than for those living in high income neighborhoods. Zenk et al (2011) use GPS tracking data to identify activity space and characterize activity space by geographical size, fast food outlet density and percentage of park land use. Employment status and car ownership are found to be significant explanatory variables of the geographic size of activity space and people without a car or not in the workforce have smaller activity space than those with a car or employed. Wang, Li and Chai (2012) make use of activity-dairy data to identify and characterize activity space. They suggest that activity space may be characterized by four dimensions, namely extensity, intensity, diversity and exclusivity. They report significant differences in the usage of time and space in terms of the four dimensions between residents of different types of neighborhoods in Beijing. In a similar way, Järv et al (2014) make use of mobile phone data to identify and examine activity space in terms of the number, geographical distribution and spatial extent of activity locations. They find significant differences along all dimensions between Estonian and Russian speakers in Tallinn, Estonia. Russian speakers are reported to visit significantly fewer activity locations, which are also more spatially concentrated compared with those visited by Estonian speakers. While this group of studies reveals how people are constrained in terms of the relative small and homogenous activity space, they ignore the social context of activity space and thus are not able to show the potentials for interaction with different others in activity space.

We argue that each of these two streams of studies only partially examines activity space segregation. They should complement each other to provide a fuller spectrum about the segregation that individuals experience in daily life. The lack of contacts between social groups may jeopardize social solidarities and thus is an important concern of segregation studies; equally important is the inequalities between social groups in access to resources and spatial opportunities, which may reduce the life chances of the disadvantaged groups. It is thus important for activity-space segregation studies to examine both the characteristics of individuals' activity space and their exposure to social environment in activity space. To the best of our knowledge, there is only one study in the literature that has made such an attempt: Jones and Pebley (2014) employ both sample survey and census data to examine activity space size and the social environment of the activity space in terms of ethnical composition, percentage of foreign-born people and poverty rate. African Americans are found to have larger activity spaces than whites, Latinos and other ethnic groups; more educated or recent movers tend to have significantly larger activity space; having friends living in the same neighborhood reduces the size of activity space. Further, they find that the socio-economic characteristics of individuals are closely associated with that of their activity space, or activity space is socially stratified; African Americans and Latinos are reported to experience a considerably broader range of places than do whites (Jones and Pebley, 2014). Comparing with previous studies, this study

provides a fuller picture about activity-space segregation. Nevertheless, a major drawback of the study is that activity space is not actually observed (e.g., through GPS tracking or activity/travel diary) but defined based on regular visited places reported by respondents and only respondents with at least three geocoded destinations are included in the study. Consequently, respondents with smaller activity space (few than three destinations) are arbitrarily excluded and the time dimension of activity space is not considered. Apparently more studies along this direction are needed to enrich the literature on activity-space segregation.

Measurements of Activity-Space Segregation

To combine the relative advantages of the two approaches identified in the previous section, this study will examine the characteristics of both activity space and its social environment for private and public housing residents in Hong Kong. This section provides more details about the two approaches to measuring activity-space segregation: those pertaining to characterize activity space and those examining the social characteristics of places where individuals are exposed in daily life or out-of-home activities.

Mobility and Activity Patterns

Mobility, accessibility and transportation infrastructure have long been related to social exclusion and inequality (Cass et al., 2005; Church et al., 2000). Activity and travel patterns, such as activity space size (Schönfelder and Axhausen, 2003), distance traveled (Morency et al., 2011) and travel mode (Bostock, 2001), have been examined as indicators of social exclusion among vulnerable social groups. Wang et al. (2012) proposed a more comprehensive framework for studying the social implications of activity-travel behavior. They use four characteristics of activity space to assess the extent to which an individual is likely to be socially integrated or segregated:

- 1) extensity: the spatial dispersal of activity space, which measures mobility and the ability to reach opportunities at a distance;
- 2) intensity: the frequency and duration of visits to certain places, which measures the significance of these places in one's daily life;
- 3) diversity: the number of different locations in one's activity space, which measures the richness of the person's social life;
- 4) exclusivity (/non-exclusivity): the degree of isolation of one's activity space, which may involve the use of private transport (e.g., cars) and exclusive spaces (e.g., members-only clubs) versus public transport and public spaces (non-exclusivity).

These four measures describe the spatial, temporal and compositional dimensions of the activity space, and hence the connection between the individual and the broader society

in day-to-day urban life. Nevertheless, none of the measures directly reflects the social interactions that take place in one's activity space, which constitute an important aspect of social isolation or integration. This interactive dimension is better described by a social isolation measure, which is based on individuals' exposure to different social groups and environments in their daily life.

Exposure and Social Isolation

An important element of social isolation is the lack of interaction across social groups. The exposure/isolation index, which assesses the social homogeneity in a residential space, has therefore become a popular measure of social segregation since its creation (Lieberson, 1981). Schnell and Yoav (2001) and Wong and Shaw (2011) extend the exposure index from the residential space to social networks and the activity space, by measuring racial segregation as the share of people in an individual's daily life environment who are of the same race as the individual. The underlying assumption is that the chance of cross-group interaction depends on the presence of different others in one's activity space. The higher the proportion of the different others, the more likely one will interact with people outside of his or her own group. In other words, he or she is then less socially isolated.

Jones and Pebley (2014) assess the exposure to social environment of activity space by developing regression models to link the socio-economic characteristics of individuals to that of their activity space. Li and Wang (2014) further developed the conceptual linkage between exposure and segregation and applied it to multiple social dimensions. Using a regression-based method, they assessed the level of segregation in a certain city or social group by the extent to which the social environments people experience in daily life match their own social identities. This method allows the examination of social isolation or segregation along both categorical and continuous variables. The more the social composition of individuals' activity spaces can be predicted by their socioeconomic characteristics, the more these individuals are socially segregated or confined to interactions with people of similar social classes.

Considering the complementary and relative advantages of the two approaches, this paper uses both methods to examine the socio-spatial experiences of private and public housing residents. Both measures are derived from the activity and travel behavior of individuals that has been collected with a diary-format questionnaire, which will be explained in detail in the next section.

Case, Data, and Variables

Apart from private housing, Hong Kong has a public housing sector, which consists of public rental housing and subsidized ownership homes. Public rental housing was initiated in the early 1950s but started full-fledged development in the 1970s (Smart, 2006). The target group of public rental housing is low-income families who cannot afford rental accommodation in the private housing market. Subsidized home ownership was also introduced in the 1970s. Subsidized homes provide opportunities for low-middle income families to purchase housing at discounted prices (about 30% lower than market price) (HKHA, 2013). According to the 2011 Population Census of Hong Kong, public and subsidized housing accounted for 49.1% of the occupied residential units and accommodated 49.7% of the population in Hong Kong.

Previous studies have found that public housing in Hong Kong does not significantly contribute to concentrated poverty, at least at the level of census tract (Delang & Lung, 2010), and that public housing tenants have rather positive views of their housing and neighborhoods (Forrest & Wu, 2014). The public housing system in Hong Kong, one of the largest in the world, seems rather successful in providing satisfactory homes and living environments for the poor. This is not to say that the social distance between the public housing and private housing residents in Hong Kong is trivial. According to Chiu (2003), the average living space of public housing tenants was only 8.6 square meters per person, just over half the space of private housing residents (16.4 square meters). Compared to private homeowners and renters, public housing residents are significantly poorer and view themselves as disadvantaged and having a lower social status, even though they are much less likely to be unemployed or on welfare than those trapped in public housing projects in the United States (Forrest & Wu, 2014).

If the concentration of public housing is a less consequential factor of the socio-spatial divide in Hong Kong, then the self-isolation of the elite may play a larger role in this divide (Forrest et al., 2004). Gated communities, the usual form of residential enclaves for the middle- and upper-class, dominate the development of private housing in Hong Kong. While some argue that the prevalence of gated communities in Hong Kong results from a number of factors, including developers' interests, land use regulations and property management systems, rather than the pursuit of privacy and safety (La Grange, 2014), it has undeniably reinforced the socio-spatial divide between private and public housing and between the rich and the poor.

To improve the understanding about socio-spatial divide between private and public housing residents in Hong Kong, this study adopts the activity space approach to comprehensively exploring the possible segregation in daily life between the two groups.

A one-day activity diary survey was conducted between July and November 2010 in Hong Kong and provided the data for comparing the socio-spatial experiences of public and private housing residents. Respondents were recruited with the assistance of a CATI

(Computer Assisted Telephone Interviewing) system, which randomly drew and dialed numbers from a telephone database containing about 300,000 fixed local lines. Out of 9261 answered calls, 1490 persons expressed willingness to participate. Those who agreed to participate were then guided to an online questionnaire, which required them to report and describe all activities and trips on the previous working day as a series of consecutive time episodes. For each episode, the survey requested the starting and ending time, location (or origin and destination if it was a trip), and the type of activity (or travel mode, for a trip episode). The questionnaire also recorded the individual's personal and household socio-economic characteristics (e.g., age, gender, income, education housing type, etc.) and information about his or her social networks. Out of the 1,490 individuals initially agreed to participate in the survey, 770 successfully completed the questionnaires.

Table 1 shows a summary of the demographics of the respondents compared to the general population in Hong Kong. Due to the web-based nature of the survey, the sample is biased towards better educated and young individuals. Females, singles and non-working individuals are also overrepresented, though the distribution of respondents between public/private housing and among the three geographical districts closely matches that of the general population.

Table 1 □ Sample profile

		N	Percentage	Population percentage (Census 2011)
Total		770	100.0	
Sex	Female	449	58.3	54.6
Age	<30	373	48.4	26.5
	30-49	283	36.8	35.5
	>= 50	114	14.8	38.0
Marital Status	Single	498	64.7	53.2
Education Level	College & above	395	51.3	37.3
Employment Status	Working	457	59.4	63.5
Monthly Household Income (HKD, 1 HKD = 0.13 USD)	19999 & below	289	37.5	47.6
	20000-39999	285	37.0	29.0
	40000 & above	196	25.5	23.5
Housing Type	private housing	386	50.1	50.3

Place of Residence	Hong Kong Island	139	18.1	18.0
	Kowloon	257	33.4	29.8
	New Territories	374	48.6	52.2

Notes: Several figures in this table require clarification. First, the population percentages by age group are based on people aged ten or above. Second, since the sample has a significantly younger age distribution than the Hong Kong population, the population percentages of sex, marital status, employment status and education attainment are weighted by the sample's age composition. Third, the population percentages of household income categories are based on household counts, while the sample percentages are based on people counts. Thus, the population percentages are not exactly comparable to the sample percentages, but they provide a rough estimate of how the sample matches or fails to match population characteristics.

Data source for population data: Census and Statistics Department, Hong Kong SAR Government

Following Schönfelder and Axhausen (2003), we define activity space as the part of the environment that respondents have visited and utilized in performing activities on the activity diary day. The constituent components of activity space include the locations where all activities are performed on the diary day. Following the four-dimensional framework proposed by Wang et al. (2012), we compare public and private housing residents' activity spaces using the seven variables shown in Table 2. The geographical *extensity* of individuals' daily lives is assessed by the standard distance between all locations in the activity space¹. The *intensity* of out-of-home activity space is measured by the time one spends out of the home and the time one spends on out-of-home activities (i.e., excluding travel time). The number of out-of-home locations visited measures the *diversity* of activity space. The *non-exclusivity* of activity space is assessed by the usage of urban public spaces, which includes both open spaces (public gardens, parks, etc.) and public life venues (churches, community centers, etc.), and non-exclusive travel modes including public transit and walking/cycling.

Table 2 □ Variables measuring the four characteristics of activity space

Dimensions	Variables
Extensity	<i>standard distance between daily activity locations</i>
Intensity	<i>total time spent out-of-home on the diary day</i>
	<i>total time spent on out-of-home activities on the diary day</i> <i>total time spent on out-of-home non-work activities on the diary day</i>
Diversity	<i>number of out-of-home locations visited in the diary day</i>
Non-exclusivity	<i>% of activity time spent at public spaces on the diary day (=1)</i>
	<i>% of travel time using public transit or walking/cycling on the diary day</i>

¹ The size or geographical coverage of activity space can be measured in many ways, such as using the total travelled distance, the maximum trip distance or the area of minimum convex polygons encompassing all destinations. Here we choose the standard distance in order to preserve as much information about the dispersal of visited locations as possible and to prevent the measurement from being dominated by the longest trips. We have also tested weighting destinations by intensity (i.e., time spent at each location) in calculating the standard distance; the results are qualitatively similar to what are presented in the paper.

The exposure of individuals in their daily lives is examined through the relationship between the type of housing (public or private) and the socio-economic composition of one's activity space. Ideally, activity space would be best characterized by the socio-economic composition of people who are present at one's activity space. They include people who are living, working, visiting, and performing other activities there. However, in reality, it is very difficult, if not impossible to get such information for obvious reasons including the dynamics of the population composition in the activity space. Thus, like other studies (e.g., Krivo et al., 2013; Jones and Pebley, 2014), we rely on the population census data, which are concerned about the residential population in activity space. We do not think that the results will be fundamentally different by using the residential population especially for the areas where residential is the dominated type of land use.

Variables used to describe the socio-economic composition of the activity space include the median income of households and workers, the percentage of people with college or higher degrees, the percentage of professional and managerial workers, the percentage of single-parent families and the percentage of private housing units. These variables are derived from the 2011 census and, in calculating the social features of an individual's activity space, these census-tract-based variables are weighted by the amount of time he or she spent at each of the activity locations of the activity space. It is assumed that more exposure to high socioeconomic status groups (high-income households, people with post-secondary degrees, professional workers, and private housing residents) may contribute to the social integration of public housing residents, while more exposure to low socioeconomic status groups (low-income households and individuals, single-parent families) may indicate greater levels of segregation of public housing residents.

Research findings

Findings from the descriptive analysis

Table 3 compares the basic profiles of respondents living in public and private housing. The two groups are systematically different in many aspects, and most of the differences are statistically significant. Public housing residents are generally younger and poorer than those living in private housing; they are also more likely to be single and less likely to own their homes. Moreover, fewer than 10% of the public housing residents have cars, and fewer than a quarter have driver's licenses, as compared to 27.7% and 40.7%, respectively, among private housing residents. The lower individual mobility of public housing residents may subject them to socioeconomic isolation if public housing projects are located in remote areas and have insufficient access to public transit.

Table 3. Basic characteristics of public and private housing residents in the sample

Percentage		Public Housing	Private Housing
<i>Female</i>		59.9	56.7
<i>Married</i>		25.0	45.6***
<i>Age below 30</i>		58.9	38.1***
<i>Managerial & professional job</i>		36.7	59.2***
<i>Homeowner</i>		43.5	80.3***
<i>Car owner</i>		9.9	27.7***
<i>Having a driver's license</i>		24.5	40.7***
<i>Undergraduate or above degree</i>		45.6	57.0***
<i>Employed or self-employed</i>		59.1	59.6
<i>Monthly household income (HKD)</i>	<i>19,999 & below</i>	49.2	25.9***
	<i>20,000-39,999</i>	38.3	35.8
	<i>40,000 & above</i>	12.5	38.3***

Significantly different at ***: $p < 0.01$; **: $p < 0.05$; *: $p < 0.1$

Figure 1 shows the geographical distribution of respondents living in public and private housing and their daily activities in densities. The degree of darkness of the colors (purple for home location and orange for activity location) shows the concentration of home or activity locations (weighted by the time duration of each activity), divided by the area of neighborhoods². As shown, public housing residents are concentrated in peripheral areas with large public and subsidized housing projects, such as West Kowloon and new towns in the New Territories, and are almost absent from the central, dense areas including southwest Kowloon and the northern coast of Hong Kong Island, where many private housing residents live. This furthers the concern that public housing residents may suffer from isolation due to both social and spatial disadvantages. The location distributions of daily activities (Figure 1-(c) and Figure 1-(d)) are less different, though public housing residents clearly perform more activities in public housing concentrated areas. To help the readers interpret the differences, we calculate the levels of dissimilarity³ between the spatial patterns of residence and activities between public and private housing residents. The dissimilarity index between Figure 1-(a) and Figure 1-(b) is 0.49, indicating that almost half of the respondents from either group need to relocate to achieve an even

² Here neighborhoods are defined on the basis of the so-called District Council Constituency Areas (DCCAs) of Hong Kong.

³ Dissimilarity is a widely used indicator for residential segregation. The formula is:

$$D = \frac{1}{2} \sum_i \left| \frac{n_{pub,i}}{N_{pub}} - \frac{n_{pri,i}}{N_{pri}} \right|$$

where $n_{pub,i}$ and $n_{pri,i}$ are, respectively, the numbers of public and private housing residents in the i th neighborhood, and N_{pub} and N_{pri} are the total numbers of public and private housing residents in Hong Kong. Time duration is used in place of number of persons in calculating the dissimilarity of activity patterns.

distribution of home locations between public and private housing residents (as a comparison, the dissimilarity index for all public & private housing residents in Hong Kong is 0.54). The dissimilarity index for activity patterns is 0.36, smaller than that for home locations but still suggesting a considerable level of difference.

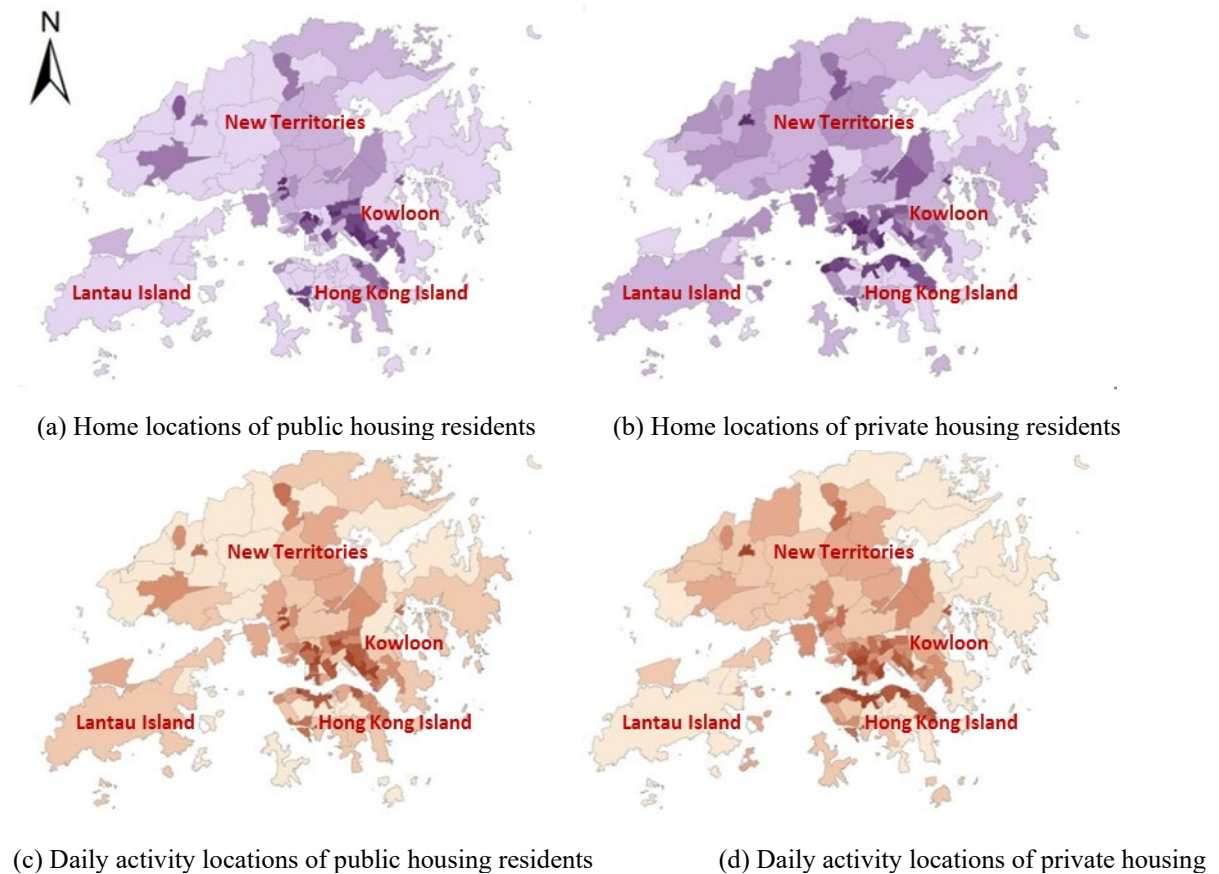


Figure 1. Location distribution of home and daily activities of public and private housing residents in the sample (Note: the degree of darkness shows the level of density—the darker the color, the higher the density of home locations or activities.)

Figure 2 shows the size and composition of public and private housing residents' social networks in terms of the number of people they had close contact with in the previous month, excluding immediate family members and inevitable contacts due to work or study-related purposes. Public housing residents, on average, have fewer social contacts than private housing residents, but the difference is not statistically significant (20.3 versus 21.4). The most prominent difference is that public housing residents have fewer social ties with extended family members than private housing residents (4.3 versus 5.6), and this difference is statistically very significant ($p=0.0009$). Moreover, they have fewer

friends (7.0 versus 7.6, not significant though) but more online friends (2.0 versus 1.3, marginally significant $p=0.1054$). Social interaction in the form of romantic relationships and other acquaintances does not substantially differ between the two groups.

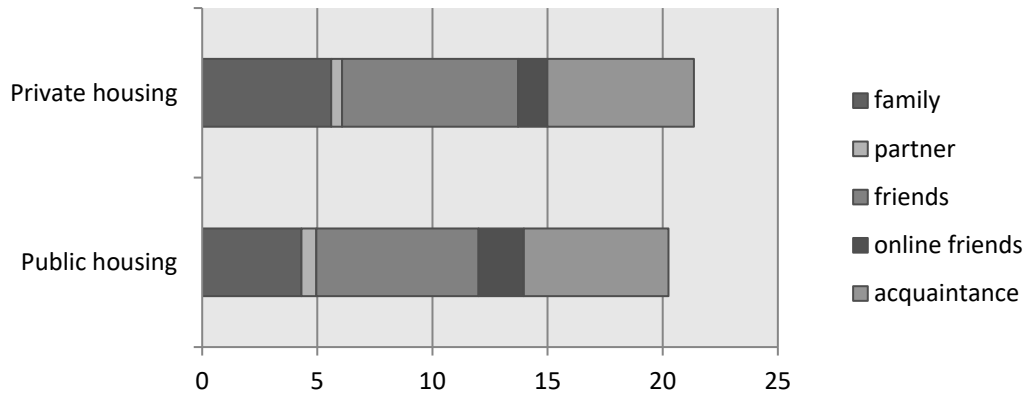


Figure 2. Social contacts of public and private housing residents in the sample

Activity Space Measures

Table 4 compares the respondents living in public and private housing using the seven variables that describe the extensity, intensity, diversity and exclusivity of their activity spaces. As shown, the two groups are not significantly different in terms of the size or diversity of activity spaces. The intensity of out-of-home activity spaces is significantly higher among public housing residents: they spend over half an hour more than private housing residents out of the home. However, that difference is almost completely driven by longer working hours. When travel time and working activities are excluded, the time spent on out-of-home activities by public and private housing residents is about the same. This suggests that the working space is probably a more important part of social life for public housing residents than for private housing residents. Public housing residents are also more likely to be walkers, cyclists or public transit passengers, probably due to their lower levels of car ownership and personal mobility. However, public housing residents do not use public spaces more than private housing residents.

Table 4. Activity spaces of public and private housing residents in the sample

Housing type		Public	Private	Total
Extensity	<i>Standard distance of destinations</i>	3.8	3.5	3.6
	<i>Out-of-home time (hr)</i>	10.4	9.8**	10.1
Intensity	<i>Out-of-home activity time (hr)</i>	8.6	8.1*	8.4
	<i>Out-of-home non-work activity time (hr)</i>	2.9	2.9	2.9
Diversity	<i>Out-of-home destinations</i>	1.5	1.5	1.5
Non-exclusivity	<i>Public space usage (% of activity time)</i>	1.8	1.8	1.8
	<i>Non-exclusive travel modes (% of travel time)</i>	97.1	91.6**	94.3

Significantly different at ***: $p<0.01$; **: $p<0.05$; *: $p<0.1$

Exposure-based Measures

While public housing residents do not appear to have smaller or less diverse activity spaces than private housing residents, the types of people in their activity spaces they are exposed to may indicate the possible segregation they experience in everyday life. Table 5 compares the social environments of the residential neighborhoods and non-residential activity spaces of public and private housing residents. In every variable listed, public and private housing residents have significant differences in their activity spaces. People who share the same urban space with public housing residents are generally less wealthy and educated, have less professional jobs and are more likely to be single parents. Moreover, public housing residents are disproportionately exposed to those who also live in public housing projects, in both residential neighborhoods and non-residential activity spaces. Here neighborhoods are defined on the basis of the so-called District Council Constituency Areas (DCCAs) of Hong Kong, which are census tract type of spatial units. Non-residential neighborhoods refer to the neighborhoods where non-home activities (e.g., working, shopping, worshipping, etc.) are conducted.

Table 5. Public and private housing residents' exposure to different social groups

Housing type	Residential		Non-residential	
	Public	Private	Public	Private
Median monthly income (HKD\$,000)				
<i>per household</i>	21.6	27.0***	27.0	29.4**
<i>per worker</i>	12.7	15.5***	15.4	16.5**
Social and family status (%)				
<i>post-secondary education</i>	21.2	26.5***	26.3	28.6***
<i>professional or managerial workers</i>	31.1	39.1***	38.3	41.4***
<i>Single-parent households</i>	13.2	10.8***	11.3	10.5***
Percentage of private housing (%)	36.9	64.1***	59.3	69.1***

Significantly different at ***: $p < 0.01$; **: $p < 0.05$; *: $p < 0.1$

To discern whether the observed differences in the social environments of activity spaces are due to other systematic differences between public and private housing residents, we use regression models to control for individual characteristics, including age, gender, marital status, educational attainment, employment status, household income, housing tenure and the availability of cars. The results are shown in Table 6. All differences shown in Table 5 remain strong and significant in residential neighborhoods (see the first column of Table 6). In non-residential activity spaces, some of the differences are explained away by other individual characteristics, especially the exposure to households and individuals with different income levels. However, social stratification by education attainment, occupation and family status remains significant between public and private

housing residents in the pooled models (the second column of Table 6). When controlling for other individual variables, locations frequently visited by public housing residents have 1.7 percentage points fewer college or higher degree holders, 2.3 percentage points fewer professionals and managers, 0.5 percentage point more single-parent families, and 8.3 percentage points more public housing than those places visited by private housing residents. While these differences are generally smaller than the differences of those in residential neighborhoods, they suggest that the two groups are exposed to systematically different social environments in their day-to-day urban lives, which may enhance residential segregation.

It is recognized that the non-residential activity space can be shaped by both individual characteristics and where the individual lives. Given that public housing projects in Hong Kong tend to concentrate in certain areas, the observed difference in activity patterns and social exposure might be due to limitation of home location and/or accessibility. Therefore, in addition to the pooled models in which the potential influences of home location are ignored, multilevel models are also used to further explore the mechanism of these differences. The multilevel model allows the intercept and the effect of living in public housing on exposure in non-residential activity space to vary across neighborhoods. It can be defined as:

$$\begin{aligned} \text{Individual level:} \quad & y_{ij} = \beta_{0j} + \beta_{1j}Pub_{ij} + \beta_2 X_{ij} + e_{ij} \\ \text{Neighborhood level:} \quad & \beta_{0j} = \gamma_{00} + \mu_{0j} \\ & \beta_{1j} = \gamma_{10} + \mu_{1j} \end{aligned}$$

where y_{ij} is a dependent variable (e.g., the median income levels in the non-residential activity space) for the i th individual living in neighborhood j , Pub_{ij} is the individual's housing status (living in public housing=1), and X_{ij} includes other individual-level factors. β_{0j} and β_{1j} are the random intercept and slope that control for neighborhood effects. The results are presented in the third column of Table 6. Removing the location effects further reduces the coefficients, most of which become statistically insignificant (though only marginally so; apart from the household and individual income levels, the other three coefficients all have p-values around 0.11-0.12). The multilevel models show that the placement of public housing projects matters. At least a portion of the observed differences in exposure in the non-residential activity space can be explained by the fact that public housing residents are living in different locations from private housing residents. These findings are consistent with that of Krivo et al. (2013) who report that there is a positive association between segregation in residential neighborhoods and in the neighborhoods where daily activities are conducted. Still, all coefficients in the multilevel models remain negative, indicating that public housing residents tend to be exposed to less socio-economically privileged groups as compared to private housing residents living

in the same neighborhoods. The differential exposure to private housing residents in non-residential activity space stays statistically significant, suggesting that even public housing residents living in more mixed neighborhoods can be isolated from private housing residents in their non-residential activity spaces.

Table 6. Regression coefficients of housing type on socio-economic characteristics of people in residential and non-residential neighborhoods

Coefficients (public housing = 1)	Residential	Non-residential	
		Pooled Models	Multilevel Models
Median monthly income (HKDS ,000)			
<i>per household</i>	-2.6591***	-1.5585	-1.0439
<i>per worker</i>	-1.5749***	-0.7190	-0.4871
Social and family status (%)			
<i>post-secondary education</i>	-3.3195***	-1.6920**	-1.1930
<i>professional or managerial workers</i>	-5.4192***	-2.2925**	-1.6151
<i>Single-parent households</i>	1.8563***	0.5172**	-0.3482
Percentage of private housing (%)	-25.9236***	-8.3311***	-5.5868**

***: p<0.01; **: p<0.05; *: p<0.1

Discussion and conclusion

Public housing residents in Hong Kong are disadvantaged in many respects. Lower socio-economic status, concentrated residential spaces and constrained personal mobility distinguish them from private homeowners and tenants. Bearing their socioeconomic differences in mind, we examined the possible social segregation that both private and public residents may experience in daily life using both the spatial/temporal features of their activity spaces and their exposure to different social groups when performing daily activities. We find that the activity spaces of public housing residents are not necessarily smaller or simpler than those of private housing residents. Instead, public housing residents have slightly more extensive activity spaces and spend more time out of the home, suggesting that they are not physically constrained in geographical sense. However, the people to whom they are exposed in their activity spaces are socio-economically different from those to whom private housing residents are exposed. The lack of exposure to people of middle to upper-middle classes (e.g., people with higher educational attainment and professional or managerial jobs) may restrain the chances of cross-group interactions and suggest that segregation between public and private housing residents may be extended to their daily activity spaces. Though our empirical results show that segregation in the residential place is more significant than in non-residential activity spaces, considering the importance of the working space in public housing residents' daily lives (since on average their working time is longer than private housing

residents'), the differential exposure in their non-residential activity space may indicate barriers to social interactions and mobility across different social classes.

This paper illustrates the use of two types of measures in examining social segregation beyond residential spaces. While the two approaches both use individual activity and travel data, they focus on different aspects of activity space and social segregation. The four dimensions of activity space capture different patterns of space usage, while the exposure measure reflects different social experiences in the usage of these urban spaces. Segregation, as detected by the first approach, indicates unequal mobility and accessibility, or other space-time constraints due to spatial concentration, insufficient physical infrastructure or other structural inequalities. In contrast, different exposure to other social groups, as revealed by the second approach, indicates a more subtle form of social segregation that can be formed by both mobility/accessibility challenges and the underlying social dynamics of segregation and exclusion.

Future studies may use activity diaries of multiple days to ensure the representation of the activity space delineated. In addition, if data are available, future studies should include not only the residential population but also working and other populations to characterize the socio-economic composition of activity space.

References

- Atkinson R, Flint J. (2004). Fortress UK? Gated communities, the spatial revolt of the elites and time-space trajectories of segregation. *Housing Studies*, 19, 875-892.
- Bauder H, Sharpe B. (2002). Residential segregation of visible minorities in Canada's gateway cities. *Canadian Geographer*, 46(3), 204-222.
- Bostock, L. (2001). Pathways of disadvantage? Walking as a mode of transport among low-income mothers. *Health & Social Care in the Community*, 9(1), 11–18.
- Bolt, G., Özüekren, A.S. & Philips, D. (2012). *Linking integration and residential segregation*. London & New York: Routledge.
- Cass, Noel, Elizabeth Shove, and John Urry (2005). Social exclusion, mobility and access. *The Sociological Review*, 53(3), 539-555.
- Chiu, R. L. (2003). Social sustainability, sustainable development and housing development. In Ray Forrest and James Lee (eds.) *Housing and Social Change: East-West Perspectives*, 221-239.
- Church, A., M. Frost, and K. Sullivan. (2000). Transport and social exclusion in London. *Transport Policy*, 7(3), 195-205.

- Delang, Claudio O, and Ho Cheuk Lung (2010). Public housing and poverty concentration in urban neighbourhoods: The case of Hong Kong in the 1990s. *Urban Studies*, 47 (7), 1391-1413.
- Ellis M, Wright R, Parks V. (2004). Work together, live apart? Geographies of racial ethnic segregation at home and at work. *Annals of the Association of American Geographers*, 94(3), 620–637.
- Farber, Steven, Antonio Páez, and Catherine Morency (2012). Activity spaces and the measurement of clustering and exposure: a case study of linguistic groups in Montreal. *Environment and Planning A*, 44 (2), 315.
- Forrest, Ray, Adrienne La Grange, and Ngai-ming Yip. (2004). Hong Kong as a global city? Social distance and spatial differentiation. *Urban Studies*, 41 (1), 207-227.
- Forrest, R., & Wu, Y. (2014). People like us? Social status, social inequality and perceptions of public rental housing. *Journal of Social Policy*, 43(01), 135-151.
- HKHA (Hong Kong Housing Authority), 2013. Policies on Public Housing (Chapter 7). <<http://www.housingauthority.gov.hk/en/about-us/policy-focus/policieson-public-housing/index.html>> (accessed 23.04.13).
- Jargowsky P A. (1996). Take the money and run: Economic segregation in U.S. metropolitan areas. *American Sociological Review*, 61(6), 984-998.
- Järv, O., Müürisepp, K., Ahas, R., Derudder, B., and Witlox, F. (2014). Ethnic differences in activity spaces as a characteristic of segregation: A study based on mobile phone usage in Tallinn, Estonia. *Urban Studies*, 1–19.
- Jones, M. & Pebley, A.R. (2014). Redefining Neighborhoods Using Common Destinations: Social Characteristics of Activity Spaces and Home Census Tracts Compared. *Demography* 51:727–752.
- Kestens, Y., Lebel, A., Daniels, M., Thériault, M., & Pampalon, R. (2010). Using experienced activity spaces to measure foodscape exposure. *Health & Place*, 16, 1094–1103.
- Krivo, L. J., Washington, H. M., Peterson, R. D., Browning, C. R., Calder, C. A., & Kwan, M. P. (2013). Social Isolation of Disadvantage and Advantage: The Reproduction of Inequality in Urban Space. *Social Forces*, 92(1), 141-164.
- Kwan, M.-P. (2012) The Uncertain Geographic Context Problem. *Annals of the Association of American Geographers* 102(5), 958-968.
- La Grange, A. (2014). Hong Kong's Gating Machine. *Housing Studies*, 29(2), 251-269.

- Li, F., and Wang, D. (2014) Measuring urban segregation based on individuals' daily activity patterns: A multidimensional approach. Working Paper.
- Liebersohn, Stanley. (1981). An asymmetrical approach to segregation. In *Ethnic segregation in cities*, edited by C. Peach, V. Robinson and S. Smith. London: Croom Helm.
- Logan J R, Stults B J, Farley R. (2004). Segregation of minorities in the metropolis: Two decades of change. *Demography*, 41(1), 1-22.
- Massey D S, Denton N A, (1987). Trends in the residential segregation of blacks, Hispanics, and Asians: 1970-1980. *American Sociological Review* 52(6) 802-825
- Manley D. & van Ham M. (2011). Choice-based letting, ethnicity and segregation in England. *Urban Studies*, 48(14), 3125-3143.
- Morency, Catherine, Antonio Paez, Matthew J. Roorda, Ruben Mercado, and Steven Farber (2011). Distance traveled in three Canadian cities: Spatial analysis from the perspective of vulnerable population segments. *Journal of Transport Geography*, 19(1), 39-50.
- Musterd S. (2005). Social and ethnic segregation in Europe: Levels, causes and effects. *Journal of Urban Affairs*, 27(3), 331-348.
- Myles J, Hou F. (2004). Changing colours: Spatial assimilation and new racial minority immigrants. *Canadian Journal of Sociology*, 29(1), 29-58.
- Palmer, J. (2012). Activity-space segregation: Understanding social divisions in space and time. Paper presented at the annual meetings of the Population Association of America, San Francisco, CA.
- Shareck, M., Kestens, Y., & Frohlich, K. L. (2014). Moving beyond the residential neighborhood to explore social inequalities in exposure to area-level disadvantage: Results from the Interdisciplinary Study on Inequalities in Smoking. *Social Science & Medicine*, 108, 106-114.
- Schnell, Izhak, and Benjamini Yoav. (2001). The sociospatial isolation of agents in everyday life spaces as an aspect of segregation. *Annals of the Association of American Geographers*, 91 (4), 622-636.
- Schönfelder, Stefan and Kay W Axhausen (2003). Activity spaces: measures of social exclusion? *Transport Policy*, 10(4), 273-286.
- Simpson L. (2004). Statistics of racial segregation: Measures, evidence and policy. *Urban Studies*, 41(3), 661-681.

- Smart, A., (2006). *The Shek Kip Mei myth: squatters, fires and colonial rule in Hong Kong: 1950-1963*. Hong Kong: Hong Kong University Press.
- Smets P, Salman T. (2008). Countering urban segregation: Theoretical and policy innovations from around the globe. *Urban Studies*, 45, 1307-1332.
- Van Kempen, R. & Wissink, B. (2014). Between places and flows: towards a new agenda for neighbourhood research in an age of mobility. *Geografiska Annaler: Series B, Human Geography*, 96(2), 95-108.
- Wang, D. and Lin, T. (2013) Built environments, social environments, and activity-travel behavior: A case study of Hong Kong. *Journal of Transport Geography* 31, 286–295.
- Wang, D., Li, F., and Chai, Y. (2012). Activity spaces and sociospatial segregation in Beijing. *Urban Geography*, 33 (2), 256-277.
- Wong, D., and Shaw, S. L.. (2011). Measuring segregation: an activity space approach. *Journal of Geographical systems*, 13 (2), 127-145.
- Zenk, S.N., Schulz, A. J., Matthews, S.A., Odoms-Young, A., Wilbur, J., Wegrzyn, L., . . . Stokes, C. (2011). Activity space environment and dietary and physical activity behaviors: A pilot study. *Health Place*, 17, 1150–1161.