Do juvenile, young adult, and adult offenders target different places in the Chinese context?

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ABSTRACT

Offenders' crime location choices have been a central theme of criminological research. However, little is known about the difference by offenders' age in their crime location choices. Based on the perspective of offender spatial decision-making, this study explores the variation in crime location choices committed by street robbers in different age groups, and examines how age-related activity nodes, journey to crime, and social disorganization influence street robbers' location choices in a large Chinese city. This study examines 7860 street robberies committed by 4358 street robbers between 2012 and 2016 in ZG city, China. A conditional logit selection model was estimated to assess street robbers' crime location choice preferences. The results demonstrate that street robbers favor areas frequented by their age group, close to their residence, and low in social cohesion. Cybercafés affect juvenile and young adult robbers' crime location choices, while transportation hubs impact those of young adult robbers and adult robbers. Schools affect all three age groups, but with a marginal age decay effect. Besides, the distance of journey to crime plays a significantly negative role in an offender's target choice, with the greatest impact in the youngest age group. These findings add insight to the clarification of the difference by age in offenders' crime location choices.

1. Introduction

Numerous studies on the interaction between geospatial and human behavior have shown that there are different activity spaces by different population groups (Hasanzadeh et al., 2021; Luan et al., 2020; Song et al., 2017; Ta & Chai, 2017; Tan et al., 2019; Wang et al., 2012). That is to say, human spatial behaviors exhibit different distributions and even some degrees of bias involving individuals' age, occupation, gender, race, culture, and other socio-economic characteristics. Further, Xiao et al. (2021) argued that "the awareness space of people is formed in their daily activities because people spent most of their time in only a few places." Similarly, this may also be true for offenders, as their illegal activities generally represent only a small fraction of their daily activities (Cohen & Felson, 1979; Kinney et al., 2008; Song et al., 2019). According to crime pattern theory (Bernasco et al., 2013; Brantingham & Brantingham, 1993), criminals prefer to commit crimes in their awareness spaces because these areas are familiar to them (Menting et al., 2016).

Further, offenders' cognitions or perceptions of their surroundings may vary by age, occupation, gender, etc. The varying perceptions lead to the formation of different awareness spaces and different activity spaces, which in turn affect their target location selection. However, the impact of the age factor is only researched in a few studies. Johnson and Summers (2015) found that in the county of Dorset, United Kingdom, offenders stealing from vehicles preferred to target places in proximity to where they resided and that places were more likely to contain daily activity nodes of significance to different age groups, such as schools for juvenile offenders, but rail stations for adult offenders (Johnson & Summers, 2015). Other relevant studies have been conducted in terms of where burglars' residential location choices, finding that more sophisticated and older burglars primarily live in disorderly or lower social status neighborhoods compared to younger burglars (Liu et al., 2018). Meanwhile, more juvenile offenders may be attracted to neighborhoods with highly residential instability (Liu et al., 2018). Accordingly, we have reasons to believe that age may be an important factor affecting offenders' preference for crime location choice. How juvenile offenders, young adult offenders, middle-aged and older offenders (abbreviated as adult offenders) behave differently needs further examination. Comparative studies among these groups can help reveal differences or peculiarities between groups, which may help devise targeted crime

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prevention and reduction strategies in places associated with age-specific activities.

The purpose of this study is to examine the offender's target choices, focusing on the preferences of offenders in different age groups. It differs in three crucial aspects from the previous research by Johnson and Summers (2015). First, although both grouped offenders by age, this article is based on a more refined age classification compared to Johnson et al.'s study. Johnson and Summers (2015) divided the 263 offenders into two age groups, i.e., juvenile offenders and adult offenders. However, following the census of China and existing related studies on burglars' residential location choices (Liu et al., 2018), this study divides the 4358 offenders into three age groups: juvenile offenders (age 12–18), young adult offenders (age 19–30), and adult offenders (age ≥ 31). Second, while Johnson and Summers (2015) studied theft from vehicles, this study is concerned with street robbery. Existing research had suggested that different crime types exhibit distinct spatial patterns and have different contributing factors (He et al., 2017; Long, Liu, Feng, et al., 2017). Studying the different crime types help enrich the testing of the generalizability of crime pattern formation theories (Johnson & Summers, 2015). Therefore, in the current study, we will examine routine activity nodes, journey to crime, and social disorganization that influence different age street robbers who commit their crimes at particular locations. Finally, the previous study is in the United Kingdom, our study in the Chinese context enhances the variety of research areas concerning criminology of place (Long et al., 2018). Thus, this study will contribute to the literature by identifying differences in street robbers' target places by their age group and providing experiences from the Chinese context.

2. Theory and research questions

The following paragraphs will briefly review the role of routine activity nodes, journey to crime, and social disorganization in the previous studies on crime location choice. Subsequently, this paper will address the differences (or preference) by age in offenders' crime location choices and understand where different age offenders commit robberies.

2.1. Crime location choice

Crime location choice refers to the offender's choice of where to commit a crime (Bernasco & Ruiter, 2014; Xiao et al., 2021). To be successful, street robbers must attack at the right place (Bernasco et al., 2017). A place may be suitable for juvenile robbers or young adult robbers because there are plenty of recreational facilities such as cybercafés, bars, clubs, etc., which are easy targets. However, the same place may be a very unattractive target area for older offenders because they are not familiar with the space or are not in it regularly. Crime pattern theory and social disorder theory usually guide the study of offenders' crime location selection (Long et al., 2021). Meantime, a growing body of research suggests that aspects of routine activity nodes, journey to crime, and social disorganization affect offenders' crime location choices (Bernasco et al., 2017; Boivin, 2018; He et al., 2017; Johnson & Summers, 2015; Liu, Lan, et al., 2020; Liu, Zhou, et al., 2020; Long, Liu, Feng, et al., 2017; Long et al., 2018; Long et al., 2021; Marques et al., 2018; Xiao et al., 2021), but most research on spatial variation in crime have ignored the age dimension. Therefore, these and other factors hypothesized to influence the crime location choice will be discussed below from three perspectives: age and routine activity nodes, age and journey to crime, and age and social disorganization. Special attention is given to offenders who commit street robberies.

2.2. Age and routine activity nodes

Crime pattern theory can predict that offenders commit crimes in their *routine* activity spaces (Menting et al., 2020), and it provides an analytical framework to understand how street robbers' location choices would be influenced by routine activity nodes (Long, Liu, Feng, et al., 2017), such as explaining that offenders commit crimes where their awareness space around activity nodes coincide with crime opportunities (Bernasco et al., 2017; Brantingham & Brantingham, 1981).

They develop the awareness space through their daily activities.

Routine activity nodes influence offenders' crime location choices. By spending a lot of time in areas with routine activity nodes, offenders can develop their knowledge on the presence of attractive targets and the level of surveillance (Brantingham et al., 2017; Brantingham & Brantingham, 1993). Areas with adequate crime opportunities would have an increased risk of being targeted. The risk is particularly high if the areas contain activity nodes frequented by motivated potential offenders (Menting et al., 2020).

More specifically, routine activity nodes are representative of the places where people frequently spend their time, including a person's residence (or home), workplace, school, recreational facilities they visit, etc. Although many people, including potential offenders, may visit many routine activity nodes, they do not have the same knowledge of each routine activity node. As a result, people visit certain activity nodes more frequently than others in their routine activities, which may affect their knowledge level (Menting et al., 2020).

As a result, for different individual offenders, some specific activity nodes exhibit different visiting frequencies, especially for different age offenders. Furthermore, recent research has shown that crimes committed by offenders are most likely to occur in the places they frequently visited (Menting et al., 2020). Thus, some of these specific activity nodes may be age-related, and they are visited frequently vary by different age offenders, and some age-related activity nodes may have different effects on where different age offenders commit crimes. For example, Johnson and Summers (2015) found that the existence of schools only has a positive contribution to the choices of crime location of juvenile offenders but not adult offenders, and the existence of train stations has a positive effect on both those of juvenile and adult offenders, only that for the latter was statistically significant. However, whether and how these activity nodes have an effect on street robbers' crime location choices in different age groups in Chinese society has not been investigated.

Based on crime pattern theory, this paper hypothesizes that different age offenders who commit robberies are more likely to choose locations with age-related activity nodes. Nevertheless, while offenders' awareness spaces could remain relatively stable in a short time, perhaps one or two years, they could vary over a longer interval (Bernasco, 2010) or due to prominent transitions in one's life (Johnson & Summers, 2015). The transition from juvenile to young adult into adult can be important in this regard. For instance, this transition may open access to replacement traffic, which reduces restrictions to travel (Townsley & Sidebottom, 2010). In addition, during these three-different periods of the life course, the relevance of routine activity nodes such as schools and recreation places or the ways they influence people's daily activities may differ (Johnson & Summers, 2015).

In sum, to better test routine activity nodes affect different ages street robbers' crime location choices, this paper divides them into two categories, one for age-related activity nodes and the other for age-unrelated activity nodes (including other activity nodes that are not strongly correlated with age). The former includes bars and clubs, cybercafés, and schools related to juvenile and young adults, and transportation hubs and wholesale markets related to young adults or adults, which are to be tested as independent variables; the latter includes malls and supermarkets, bus stops, subway stations, and car parks, to be used as control variables in the models.

2.3. Age and journey to crime

Activity space is formed in activity nodes that people visit in their daily activities and the routes used to travel between them (Menting et al., 2020). Brantingham et al. (2017) argued that active space and all

areas under the visible sphere shape the awareness space. People typically get relevant spatial information from their awareness space, but they have very limited or no knowledge about non-active spaces. Based on crime pattern theory, offenders commit crimes in areas where their awareness space overlaps with the spatial distribution of attractive targets. Offenders' awareness spaces at least include the region surrounding their homes (or residences). According to the principle of least effort, they would more likely to conduct activities near their residence because traveling further requires more effort and time. As a result, the more distant areas were generally less known to them.

All research to date on crime location choice has indicated that criminals prefer to perpetrate crimes close to their residences as opposed to more distant areas (Andresen et al., 2014; Bernasco, 2010; Bernasco & Block, 2009; Clare et al., 2009; Lammers et al., 2015; Long et al., 2021; Menting et al., 2020; Song et al., 2019; Townsley & Sidebottom, 2010; Xiao et al., 2021). Meanwhile, existing studies have found that the socioeconomic attributes of offenders such as age, occupation and gender have distinct effects on their journey distances to crime through comparative analyses (Andresen et al., 2014; Bichler et al., 2011; Chainey et al., 2001; Groff & McCord, 2012). Existing literature showed that younger offenders commit crimes closer to their residences than older offenders. For example, previous studies of riots by Baudains et al. (2013) and residential burglary by Clare et al. (2009) found that younger criminals were inclined to commit crimes closer to their residence than those of adults. In particular, Johnson and Summers (2015) found that juvenile perpetrators tend to carry out crimes near their home sites more so than their older perpetrators, and near the nodes of daily activity that are particularly relevant to them.

So far, the empirical findings in the Chinese context are also consistent with those in the Western context. For instance, Hou et al. (2020) found that young adult offenders had a larger crime travel distance to commit electric bicycle theft than juvenile and adult offenders in Beijing, China. Xiao et al. (2018) confirmed that older burglars traveled further distances to offend than the younger burglars in Guangzhou, China. However, the above findings are not directly related to the target choices in robberies committed by different age offenders in the Chinese context, and their preferences on target location selection need to be examined.

2.4. Age and social disorganization

The theory of social disorganization suggests that criminals prefer to target areas where residents are least likely to establish social relations, either because the residents derive from various socio-economic backgrounds, as well as because population mobility is relatively high (Johnson & Summers, 2015). For example, Bernasco and Nieuwbeerta (2005) found that an area's society composition may affect burglars' decision-making. Baudains et al. (2013) noted that several proxies in terms of social cohesion, such as population turnover and deprivation, are related to the spatial decision-making of offenders in London riots. In particular, Johnson and Summers (2015) showed that juvenile and adult offenders (theft from vehicles) favor areas with low social cohesion in Dorset, UK. Hesseling (1992) found that adult offenders were more likely to stay in a socially disrupted community than juvenile offenders. However, the above should be validated in the Chinese context because the preferences of juvenile, young adult, and adult offenders have not been unexplored.

Social disorganization theory is concerned with how a neighborhood's social composition enables it to deter or facilitate criminal activity (Bursik, 1988; Shaw & McKay, 1942). Generally, people prefer to associate with others who hold similar social-demographic features rather than undertake activities associated with other social groups' members (McPherson et al., 2001). This homogeneity coupled with the fact that various kinds of social groups usually reside in distinct parts of the city would result in people from different social groups having different awareness spaces. The vast majority of people's daily activities

occur in their settlements. However, as they embark on a travel to alternative regions, they are much less inclined to travel to areas inhabited by different groups, but rather to places inhabited by similar social groups (Xiao et al., 2021). For example, young people would prefer neighborhoods with high-proportion young adults, while migrants favor neighborhoods with high-proportion foreigners of the same ethnicity. Bur for different age street robbers, it needs to be tested whether they follow this prefer to crime.

At the same time, existing research is mainly concerned with cities in the United States and the United Kingdom, as well as other Western industrialized countries, where social disorganization is described as the failure of a local neighborhood to address commonly experience problems or realize the shared values of their inhabitants (Song et al., 2019), and it is theoretically and empirically related to residential instability, ethnic heterogeneity, and socioeconomic disadvantage (Bursik, 1988; Sampson et al., 1997). Research shows that social cohesion provides more opportunities for social relationships, especially in neighborhoods with demographic stability (Braga & Clarke, 2014; Coleman, 1988). Residents of homogenous neighborhoods are more likely to have similar or common beliefs and goals (Galster & Santiago, 2017; Johnson & Summers, 2015). Ethnic diversity is an oft-discussed factor that hinders social cohesion (Sampson & Groves, 1989). This is particularly relevant for perpetrators in ethnically or racially mixed cities (Bernasco et al., 2017; Bernasco & Block, 2009; Leal & Mier, 2016; Menting et al., 2016).

However, in the context of China, social disorganization in a city is not mainly based on ethnic or racial differences, but is related to the demographic composition of neighborhoods, including the concentration of domestic migrants (Song et al., 2019; Xiao et al., 2021; Zhu, 2007) and the proportion of young people (Liu et al., 2018; Long, Liu, Zhou, et al., 2017; Xiao et al., 2018). It is well known that China has undergone a massive domestic migration over the past forty years. The primary social issue facing China in terms of public safety in recent decades has been the fast-growing urban population, particularly the migrant population in cities (Long & Liu, 2021). Notably, the increase in urban crime is one of the negative outcomes of the influx of large-scale domestic migrants into the city (Feng et al., 2019). Long and Liu (2021) argued that "The foothold of Chinese domestic migrants is different from that of international immigrants. The former arrives in another domestic city for employment, and the latter moves to another country mainly for settlement". China's domestic migration is constrained by the institutional barriers of the household registration system (also is known as Hukou) (Han, 1999; Zhu, 2003), and they do not enjoy the same benefits or rights of the city as local residents, such as pay, housing, healthcare, and education. Rural migrant workers, in particular, tend to experience isolation from the locals and suffer from well-being or poverty problems (Du et al., 2017). The alienation between local residents and domestic migrants has created different activity spaces and isolated social networks (Xiao et al., 2021). Studies have shown that there is very limited overlap in social networks among local residents and domestic migrants (Zhao & Wang, 2018).

Age is also an important factor, as people prefer to associate only with their age peers. This preference exists among offenders. Several studies have confirmed young adults proportion has a substantial effect on offending (Curran, 1998; Liu et al., 2018; Long, Liu, Zhou, et al., 2017; Qi, 2020; Xiao et al., 2018). But the impact of age on offenders' crime location choices has not yet been examined.

In sum, the research question of this paper is whether street robbers' crime location choices vary by age? Secondly, how do routine activity nodes, journey to crime, and social disorganization affect juvenile, young adult, and adult robbers' target place selection?

3. Material and methods

3.1. Study area and crime data

ZG City is one of the major cities in the southeast coastal region of

China, a national central city and the core of the Guangdong-Hong Kong-Macao Greater Bay Area, and has been the political, economic, scientific, educational, and cultural center of southern China. Due to the complexity of the social composition, ZG City has been regarded as the best place to study the crime location choices by different age-attributed street robbers. The area under study comprises 1971 neighborhood units with an average area of 1.62 km^2 (Long et al., 2021).

In this paper, ZG City Public Security Bureau provided crime data on arrested offenders and their robberies during the period 2012 to 2016 (Long et al., 2021). The data in this paper and those of Long et al. (2021) are derived from the same dataset for ZG City, but they have different research questions. This paper identifies the differences by age in offenders' crime location choices, while Long et al. (2021) examine the impacts of ambient population and surveillance cameras on street robbery. Meanwhile, based on the Chinese population census and following the practice of Liu et al. (2018), in this study, 4358 street robbers are divided into three age groups: juvenile robbers, young adult robbers, and adult robbers. Respectively, the three age groups of robbers account for 21.02 % (916), 49.86 % (2173), and 29.12 % (1269) of all the street robbers.

3.2. Routine activity nodes variables

To test the routine activity nodes' effects on juvenile offenders, young adult offenders, adult offenders, this study used the ZG City's POI data for constructing routine activity nodes variables and they were measured by their number in a neighborhood. Based on the elaboration in the second section above, this paper divided the routine activity nodes into two types of variables, one is age-related activity nodes as independent variables, including bars and clubs, cybercafés, schools, transportation hubs, and wholesale markets; the other is age-unrelated activity nodes as control variables, including malls and supermarkets, bus stops, subway stations, car parks (Table 1).

3.3. Journey to crime variables

Following Bernasco et al. (2017) and other prior offenders' crime location choice research (Long et al., 2021; Menting et al., 2016; Xiao et al., 2021), the distance of journey to crime as an independent variable is represented by the Euclidean distance from the centroid of each of neighborhood units to the offender's residence location. The mean of the distance variable is 14.35 km and with a standard deviation of 8.89 km. In addition, it should be noted that due to its Poisson-like distribution, a log-transformation is performed on the distance variable.

Table 1
Descriptive statistics of neighborhood characteristics (N = 1971).

Variables	Code	Mean	SD	Min	Max
Age-related activity nodes					
Bars and clubs (#)	x_1	1.37	2.34	0	21
Cybercafés (#)	x_2	0.43	0.94	0	11
Schools (#)	x_3	0.46	0.96	0	7
Transportation hubs (#)	x_4	0.06	0.37	0	9
Wholesale markets (#)	x_5	1.52	2.56	0	24
Social disorganization					
Migrants proportion (%)	x_6	0.47	0.25	0	1
Young adults proportion (%)	x_7	0.26	0.11	0.07	0.90
Control variables					
Malls and supermarkets (#)	x_8	3.26	5.46	0	59
Bus stops (#)	x_9	2.91	4.41	0	96
Subway stations (#)	x_{10}	0.31	1.20	0	14
Car parks (#)	x_{11}	5.81	7.51	0	69

3.4. Social disorganization variables

The proportion of migrants and the proportion of young adults in a neighborhood were used to represent social disorganization (Curran, 1998; Liu et al., 2018; Long, Liu, Zhou, et al., 2017; Song et al., 2019), and they were generated from the census data of ZG City. They were acted as independent variables and measured as the total number of migrants (or young adults) in a neighborhood divided by the total number of people in the same neighborhood.

Finally, the independent and control variables were tested for multiple collinearities through correlation and regression analysis. The correlation coefficients among all variables were small than 0.60, with a maximum VIF of 1.79 and an average VIF of 1.42 (in Table 2). Therefore, multicollinearity is not an issue in this study.

3.5. Conditional logit selection models

The conditional logit selection models have been applied to various discrete choice behaviors, including offender's crime location choice problems (Bernasco et al., 2013; Bernasco & Nieuwbeerta, 2005). This approach allows for the incorporation of offender-level and area-level attributes to clarify why offenders committed crimes in specific places. Consistent with most existing discrete spatial choice modeling studies (Bernasco & Nieuwbeerta, 2005; Baudains et al., 2013; Lammers et al., 2015; Long et al., 2018; Long et al., 2021; McFadden, 1978; Xiao et al., 2021), the research question of this paper will be tested by conditional logit models. In this paper, the locations of the robbery were geocoded into one of 1971 neighborhoods as the dependent variable. For each robbery, the neighborhood where the robbery took place is recorded as "1" and all other neighborhoods are recorded as "0". In addition, it should be noted that there are two approaches for comparing the behavior of different groups. One is to grade age with dummy variables such as 0, 1, etc., and to study the interaction variables of age-graded dummies with other explanatory variables in a single model; the other is to build separate models for different groups (Liu et al., 2018; Johnson & Summers, 2015). The former approach is used in this study, due to its advantages in exploring interactions between variables.

4. Results

The results of conditional logit selection models are presented in Table 3 (Pseudo R^2, Odds Ratios, Standard Error, Z-scores, and significance level with 95 % confidence intervals). The pseudo R^2 value of the Model is >0.20, which indicates that the model in this paper has a better explanatory ability.

The results of control variables show the impact of bus stops, subway stations, malls and supermarkets have the most significant, while car parks do not have a significant effect. For instance, with one more bus stop or mall and supermarket in a neighborhood unit, the odds ratios of being chosen increase by 14.0 % and 22.3 % respectively.

In Table 3, the conditional logit selection models and the significant differences in the odds ratios of variables confirm street robbers' crime location choices vary by age. For example, the odds ratio of cybercafés respectively is 1.070 and 1.092, with p-values <0.001, which means the influence of cybercafés on juvenile robbers and young adult robbers is positive and highly statistically significant. On the other hand, although the odds ratio of cybercafés on adult robbers is positive, it's not statistically significant (p = 0.095).

Similarly, the influence of transportation hubs on young adult robbers and adult robbers is statistically significant at the 95 % confidence level, and with an estimated odds ratio of 1.035 and 1.075 for them, but for juvenile robbers is insignificant (p = 0.079). This indicates a significant difference in the effect of transportation hubs on juvenile robbers and adult robbers, a slightly significant difference in the effect on juvenile robbers and young adult robbers, but no significant difference in the effect on young adult robbers and adult robbers.

Table 2

Correlation and regression results for independent and control variables.

Variables	VIF	x₁	x₂	x₃	x₄	x₅	x₆	x₇	x₈	x₉	x₁₀	x₁₁
x₁	1.71	1										
x₂	1.49	0.38	1									
x₃	1.06	0.13	0.13	1								
x₄	1.09	0.10	0.15	0.03	1							
x₅	1.38	0.29	0.38	0.14	0.18	1						
x₆	1.40	0.17	0.30	0.13	0.05	0.26	1					
x₇	1.49	0.14	0.29	0.09	0.05	0.17	0.47	1				
x₈	1.79	0.36	0.48	0.16	0.11	0.42	0.35	0.40	1			
x₉	1.38	0.20	0.21	0.18	0.10	0.24	0.17	0.34	0.43	1		
x₁₀	1.15	0.19	0.04	0.02	0.22	0.09	0.00	0.03	0.10	0.09	1	
x₁₁	1.70	0.57	0.22	0.14	0.15	0.31	0.16	0.12	0.22	0.25	0.30	1

Table 3

Evaluation results among juvenile robbers, young adult robbers, and adult robbers.

	OR	SE	Z	p > z	[95 % conf. interval]	
Juvenile robbers×bars and clubs	1.088***	0.020	4.53	0.000	1.049	1.129
Juvenile robbers×cybercafés	1.070**	0.026	2.82	0.005	1.021	1.121
Juvenile robbers×schools	1.162***	0.029	5.93	0.000	1.105	1.220
Juvenile robbers×transportation hubs	1.033	0.019	1.76	0.079	0.996	1.072
Juvenile robbers×wholesale markets	1.088**	0.029	3.12	0.002	1.032	1.147
Juvenile robbers×logdistance	0.194***	0.005	−66.78	0.000	0.185	0.203
Juvenile robbers×migrants proportion	1.174**	0.055	3.42	0.001	1.071	1.287
Juvenile robbers×young adults proportion	0.976	0.037	−0.65	0.514	0.907	1.050
Juvenile robbers (ref.)	1				1	1
Young adult robbers×bars and clubs	1.085**	0.030	3.01	0.003	1.029	1.145
Young adult robbers×cybercafés	1.092***	0.017	5.73	0.000	1.059	1.125
Young adult robbers×schools	1.101***	0.025	4.23	0.000	1.053	1.152
Young adult robbers×transportation hubs	1.035**	0.012	3.07	0.002	1.012	1.058
Young adult robbers×wholesale markets	1.078***	0.019	4.27	0.000	1.041	1.116
Young adult robbers×logdistance	0.212***	0.003	−97.18	0.000	0.205	0.219
Young adult robbers×migrants proportion	1.066*	0.032	2.17	0.030	1.006	1.130
Young adult robbers×young adults proportion	1.105***	0.025	4.40	0.000	1.057	1.155
Young adult robbers (ref.)	1				1	1
Adult robbers×bars and clubs	1.074**	0.026	2.98	0.003	1.025	1.126
Adult robbers×cybercafés	1.036	0.022	1.67	0.095	0.994	1.080
Adult robbers×schools	1.098***	0.019	5.25	0.000	1.060	1.137
Adult robbers×transportation hubs	1.075***	0.012	6.51	0.000	1.052	1.099
Adult robbers×wholesale markets	1.086***	0.025	3.61	0.000	1.039	1.136
Adult robbers×logdistance	0.227***	0.005	−70.54	0.000	0.218	0.237
Adult robbers×migrants proportion	1.101*	0.041	2.57	0.010	1.023	1.186
Adult robbers×young adults proportion	1.051	0.031	1.70	0.090	0.992	1.114
Adult robbers (ref.)	1				1	1
Control variables						
Malls and supermarkets	1.223***	0.012	20.78	0.000	1.200	1.247
Bus stops	1.140***	0.010	15.19	0.000	1.121	1.159
Subway stations	1.065***	0.012	5.84	0.000	1.043	1.088
Car parks	0.987	0.017	−0.76	0.449	0.955	1.021
Pseudo R²	0.283					

* p<0.05.
** p<0.01.
*** p<0.001.

Meantime, young adults proportion only statistically significant effect on young adult robbers (for juvenile robbers, OR = 0.976, p = 0.514; for the adult robbers, OR = 1.051, p = 0.090). It might be the daily activities formed by young adult robbers and its sphere of influence, which suppresses juvenile robbers' and adult robbers' activities space.

Therefore, cybercafés, transportation hubs, young adults proportion have different effects on the different age street robbers' crime location choices. Unlike adult robbers, cybercafés are significantly affecting juvenile and young adult robbers' target places. While transportation hubs impact young adult and adult robbers' crime location choices, but not juvenile robbers'.

Furthermore, although the presence of bars and clubs and schools appears to influence the crime location choices of juvenile, young adult, and adult robbers, the OR value of schools for adult robbers is closer to 1 than for juvenile robbers and young adult robbers, which indicated there

is a slight marginal age decay effect (for juvenile robbers, OR = 1.162, p < 0.001; for young adult robbers, OR = 1.101, p < 0.001; for the adult robbers, OR = 1.098, p < 0.001). However, the p-values for bars and clubs' OR in the three age groups were <0.01, showing that there was no significant difference in the effect of bars and clubs between the three age groups.

Besides, the distance of journey to crime strongly and negatively affects a street robbers' whereabouts, especially the younger the age, the greater the impact (for juvenile robbers, OR = 0.194, p < 0.001; for young adult robbers, OR = 0.212, p < 0.001; for the adult robbers, OR = 0.227, p < 0.001). Therefore, the distance of journey to crime plays a significantly negative role in an offender's target choice, with the greatest impact in the juvenile age group.

In addition, the presence of wholesale markets in a neighborhood upped the probability of a robber committing a crime in that neighborhood, but the effect has not been found to vary different age robbers.

Similarly, the effect of migrants' proportion is consistent with this finding.

5. Discussion and conclusions

The findings highlight that categorizing street robbers by age can uncover hidden spatial preferences that have been overlooked in the previous research. In the current study, we conclude that street robbers prefer areas with age-related activity nodes, which is consistent with the finding of Johnson and Summers (2015). However, it should be noted that there are still some slight differences between our findings and those of Johnson and Summers (2015) on specific variables.

Concerning the "schools" variables, Johnson and Summers (2015) found that schools are significantly affecting juvenile robbers' target places, but not adult robbers. However, we demonstrate that schools influence crime location choices not only for juvenile and young adult robbers but also for adult robbers. The possible reason is that Chinese and Western countries differ in their urban form and functional layout. Currently, the vast majority of ZG city in China is mixed residential, work, and recreational areas with a large number of routine activity nodes. In particular, ZG city is well served by public transportation including buses and subway, and schools are located near bus stops and subway stations. The result is that the activity space of adult robbers in ZG city largely covers the area where the schools are located.

According to crime pattern theory, offenders often commit an offense where crime opportunities overlap with their awareness space surrounding activity nodes (Bernasco et al., 2017; Brantingham & Brantingham, 1981). Thus, schools in a neighborhood also provide crime opportunities for adult robbers, and this effect may be a collateral effect.

Furthermore, we found the effect of school on crime location choice was progressively lower for juvenile robbers, young adult robbers, and adult robbers, with the OR values of 1.162, 1.101, and 1.098, respectively. In other words, the effect of school was reduced by 5.1 % for young adult robbers relative to juvenile robbers and by 6.4 % for adult robbers. Thus, there is a slight marginal age-decay effect in ZG city, China. That is, the older the age, the smaller the effect. One potential interpretation of this discovery is that the three age groups differed in the frequency and timing of visits to and around the school. This finding is in agreement with those of Menting et al. (2020), who showed that offenders are much more likely to commit crimes in their activity space than elsewhere and that the effect increases with the frequency of visits. Although school activity nodes may be visited by many juveniles and young adult offenders, including adult offenders, they are not equally known to these nodes.

Also, compared to the study by Johnson and Summers (2015), we examined more age-related activity nodes, such as cybercafés, transportation hubs, bars, clubs, etc., and found that street robbers were more likely to target places that might include daily activity nodes of significance to their age groups, such as cybercafés in the case of juvenile and young adult robbers, transportation hubs in the case of adult robbers, schools with a marginal age decay effect.

Concerning the journey to crime, our results show that street robbers favor areas near their homes, especially for juvenile offenders, which is consistent with previous research (Baudains et al., 2013; Hou et al., 2020; Johnson & Summers, 2015; Xiao et al., 2018). Thus, in the Chinese context, we further identified that the distance of journey to crime is a crucial factor in inhibiting different age offenders to choose targets far from their residences. The consistent findings based on the Chinese and Western contexts inspire future theoretical and applied research. For example, theoretical studies on the shaping mechanistic of different age offenders' crime location choices could use distance as a control variable; in terms of policing applications, these results have potential implications for the use of geographic profiling by police officers when investigating Chinese different age serial street robbers, such as forecasting the residence location of a fugitive offender based on the offenders' crime location information.

With the aspect of social disorganization, this finding shows that street robbers favor areas with low social cohesion. On the one hand, the differential effect of young adults proportion on juvenile, young adult, and adult offenders' crime location choice is a particularly novel result. In this article, it is found that the target places coefficient is positive for both young adult robbers and adult robbers, however, it is negative for juvenile robbers and statistically significant only for young adult robbers. Three potential explanations for this finding are as follows: First, young people prefer neighborhoods dominated by young people, and their target places are similar to the preferences described above. People prefer to interact with others with similar social-demographic characteristics than undertake activities with other social groups (McPherson et al., 2001). Most people's routine activities occur in their residential areas, and when they go to other regions, they are much less likely to go to places where other groups live, but to places where similar social groups live (Xiao et al., 2021). Second, youth-adult group's activity space in a neighborhood inhibited or narrowed those of juvenile robbers and adult robbers. In short, the more young population in a neighborhood has, the more the majority of activities in that neighborhood are taken up by youth, with relatively little activity from the other two groups. Finally, juvenile offenders' crime location choices would avoid selecting neighborhoods with many young people and disorders. This is consistent with Hesseling (1992) and Liu et al. (2018) who found that adult offenders preferred to live in a socially disrupted neighborhood compared to juvenile offenders.

On the other hand, our findings indicate that migrants' proportion affects juvenile, young adult, and adult robbers' target places. According to social disorganization theory, offenders appear to be more likely to target areas with residents who are least likely to form positive social relationships, either because the residents have various socio-economic contexts, or because population mobility is relatively high (Baudains et al., 2013; Bernasco & Nieuwbeerta, 2005). Meantime, this result is in line with those of Johnson and Summers (2015), who find that juvenile and adult offenders are more likely to target areas with low social cohesion in Dorset, UK. Therefore, these results also supplement prior studies that confirm the impact of relevant neighborhood factors and social cohesion in accounting for the spatial preferences of age-specific offenders in Chinese contexts.

In summary, this study is deeply rooted in the extensive literature on social disorganization theory and crime pattern theory. Most of the previous research has concentrated on offenders' crime location choices, and little is known of the difference across age. This study demonstrates that street robbers favor areas that are activity nodes frequented by their age group and closer to their residence and low in social cohesion. For example, cybercafés affect juvenile and young adult robbers' crime location choices, while transportation hubs impact those of young adult robbers and adult robbers. Schools affect all three age groups, but with a marginal age decay effect. Besides, the distance of journey to crime plays a significant negative role in the offender's target choice, with the greatest impact in the youngest age group. Interestingly, young adult robbers are more likely to target neighborhoods where young adults concentrate, but not juvenile and adult robbers. Thus, in the Chinese urban context, this study for the first time finds that street robbers' crime location choices vary by age.

These results have contributed to the development of cumulative knowledge about street robbers' target places and provide insights into police investigations. As Snook et al. (2005) claim that "any research that can contribute to understanding how age may predict offenders' spatial decision-making is valuable". And the findings of this paper add a valuable piece to the clarification of age-specific differences in Chinese offenders' crime location choices. As with any study, we should acknowledge that the current study has some limitations and shortcomings. Firstly, only nine types of routine activity nodes and two types of social disorganization have been explored. In future studies, more activity nodes and social disorganization types should be considered, and more crime types and more regions should be investigated to

conduct cross-validation of our findings. Secondly, additional attributes of offenders should be included in future studies. Such attributes may include age, household registration, socioeconomic status, and other individual information for a more refined analysis. Finally, this paper has found that the odds ratios of most variables in the conditional logit selection models aren't much >1 or far <1. While these do not meet the high standard of odds ratios <0.67 or >1.57 originally proposed by Chen et al. (2010) for epidemiological studies, they are indeed consistent with those of the existing mainstream literature that examined the location choice of a large number of offenders (Bernasco & Nieuwbeerta, 2005; Kroese et al., 2021; Kuralarasan & Bernasco, 2022; Song et al., 2019). While odds ratios below 0.67 or larger than 1.5 are desirable, much of the existing mainstream literature in the field of crime geography and environmental criminology, especially discrete spatial choice modeling does not meet this specification. Reasons for the rather sharp variation on the odd ratios between epidemiology and crime geography need to be explored in the future studies.

Author statement

(1.) The manuscript is our original research;
(2.) It has not been submitted elsewhere in print or electronic form to another journal or as a proposed book chapter;
(3.) It has not been published previously or otherwise accessible to the public (e.g., posted on the website);
(4.) No similar or exact submission will be sent elsewhere until your review is completed.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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