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Assessment and determinants of satisfaction with urban livability in China

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ABSTRACT

Building livable cities has been an important goal for new urbanization in China. Thus, understanding residents' satisfaction with urban livability in China and its determinants is beneficial for urban planning and policy making regarding livable cities construction. However, scientific evidence on satisfaction with urban livability towards Chinese cities is still lacking. Drawing on large-scale questionnaire surveys conducted in 2015 in 40 major cities in China, this paper aims to explore the characteristics of satisfaction with urban livability and the effect magnitude of its determinants using the geographical detector model. The results show that the respondents are just moderately satisfied with urban livability in China (2.996). With respect to the dimensions of urban livability, the respondents are relatively satisfied with the convenience of public facilities (3.118), the natural environment (3.057) and the sociocultural environment (3.056), while slightly dissatisfied with urban security (2.788), environmental health (2.912) and convenient transportation (2.929). The result of the geographical detector model further reveals that all the six dimensions of urban livability have significant and positive impacts upon overall satisfaction with urban livability, of which the natural environment, convenient transportation, environmental health are the greatest contributing factors. Moreover, individual socioeconomic attributes such as geographical location, type of housing, education, family size, age, *hukou* status, also exert significant effects on overall satisfaction with urban livability in descending order, but the magnitude of their effects is far less than that of the dimensions of urban livability.

1. Introduction

With rapid economic growth and urbanization, the past few decades have witnessed tremendous changes in the built and sociocultural environments in the urban areas of China. However, the rapid development in many Chinese cities has also led to many urban issues, such as crime, air pollution, traffic congestion, and inadequate public facilities particularly in new districts, as well as socio-spatial disparities in metropolitan regions (Li & Wu, 2007; Ouyang et al., 2017; Zhang & Gao, 2008), posing great challenges to urban livability. Nevertheless, research has suggested that the quality of the urban environment is positively associated with individual wellbeing (Dong & Qin, 2017; Kytta et al., 2016) and urban competitiveness (Dragin-Jensen, Schnittka, & Arkil, 2016). To this end, Chinese central government has called for building livable cities with people-oriented ideas in recent years, and a series of livable cities promotion policies were issued successively, including the National Plan on New Urbanization in 2014, the Central Urban Work Conference held in 2015, and the 13th Five-Year Plan announced in 2016. Therefore, understanding the characteristics of satisfaction with urban livability in China and its determining factors is essential for offering new insights into livable city construction and enhancing residents' life satisfaction in urban China.

Urban livability is a multifaceted concept associated with many domains of the living environment in urban areas, involving both the physical and sociocultural environments (Kashef, 2016; Norouzian-Maleki et al., 2015). Past studies have provided a better understanding of the assessment and influencing factors of the quality of the urban environment (Mahmoudi, Ahmad, & Abbasi, 2015; Saitluanga, 2013).

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These studies, however, have several limitations. First, a majority of the extant studies have overemphasized the role of economic factors in affecting the quality of the urban environment. They often yielded counterintuitive findings that are contrary to local residents' actual lived experiences (Easterlin et al., 2012; Okulicz-Kozaryn, 2011). Therefore, a scientific evaluation framework of urban livability is needed in order to reflect urban residents' real expectations about their living environment. Second, most studies have evaluated the quality of the urban environment from an objective perspective (Ogneva-Himmelberger, Rakshit, & Pearsall, 2013), but little is known about residents' subjective evaluation of the urban environment because of the lack of relevant data, especially at the regional and national scales in developing countries. Lastly, from a methodological point of view, previous research has seldom compared the effect intensity of the influencing factors on people's satisfaction with their urban environment due to the limitations of traditional regression methods (Fleming, Manning, & Ambrey, 2016; Permentier, Bolt, & van Ham, 2010).

To fill these knowledge gaps, this study pays special attention to residents' satisfaction with urban livability in China at the national scale and uses the geographical detector method to identify the effect intensity of its determinants. Although extensive efforts have been devoted to the analysis of residential satisfaction focusing on the urban environment at the neighborhood scale (Gentile, 2005; Mohit, Ibrahim, & Rashid, 2010; Shon, 2007), it should be noted, however, that there is important difference between satisfaction with urban livability and residential satisfaction. As articulated as the uncertain geographic context problem (UGCoP) (Kwan, 2012a; Kwan, 2012b), individual health outcomes or life satisfaction is influenced not only by where one lives (the residential context) but also by where one travels to or visits to undertake one's daily activities. For instance, several recent studies on wellbeing (Schwanen & Wang, 2014), individual air pollution exposure (Park & Kwan, 2017), and healthcare satisfaction (Cabrera-Barona, Blaschke, & Gaona, 2017) have all underscored the importance of taking into account the influence of people's non-residential contexts on their health and wellbeing (Kwan, 2013). Likewise, individual satisfaction with urban livability is also associated with the satisfaction people experience when they travel and undertake their daily activities within and outside their residential areas - in other words, their life experiences of both their residential and non-residential environments.

Guided by the notion of the UGCoP, this study aims to examine residents' satisfaction with urban livability and its determinants across 40 major cities in China using large-scale questionnaire surveys conducted in 2015. In particular, we seek: (1) to build an appropriate concptual framework for evaluating residents' satisfaction with urban livability in Chinese cities; (2) to explore the characteristics of satisfaction with urban livability in China to provide evidence for livable cities construction; (3) to identify the effect magnitude of the factors that influence the overall satisfaction with urban livability.

2. Literature review on urban livability

2.1. Definitions and measurements of urban livability

As one of the most crucial elements of urban quality of life and city attraction, urban livability has received increasing attention in various fields (Badland et al., 2014; Norouzian-Maleki et al., 2015; Pacione, 1990). However, there is still no unified definition and measurement of urban livability in the literature due to its complex and multi-dimensional nature. For instance, livability has been defined as suitability for human living (Merriam-Webster, 2017), the quality of life experienced by the residents of a city or region (Timmer & Seymoar, 2005), and the standard of living or general wellbeing of the population in an area (Okulicz-Kozaryn, 2011), all of which indicate that livability is a broad term encompassing a number of urban environment characteristics that affect the attractiveness of a place (Norouzian-Maleki et al., 2015). More specifically, some claimed that livability refers to the human requirement for social amenity, health, and wellbeing, and includes both individual and community wellbeing (Newman, 1999). Some authors posited that a livable city facilitates a healthy life, increases the chance for easy mobility, and serves as the city for all people (Hahlweg, 1997), while others argued that both livelihood and ecological sustainability are crucial for making cities livable (Evans, 2002). In this study, urban livability is defined as the urban quality of life and individual wellbeing related to the local urban environment, and its level is measured by the difference between one's actual and expected urban environment quality from the perspective of satisfaction.

Consistent with the diversified conceptualizations of urban livability, no consensus has been reached on the measurement of urban livability to date. This is perhaps because the evaluation criteria of urban livability vary across different places (Ruth & Franklin, 2014) and different people according to their personality, culture, national backgrounds, traditions, and expectations (Sofeska, 2017). A case study in Australia, for example, showed that urban livability assessment comprised of 11 specific domains, involving natural environment, crime and safety, education, employment and income, health and social services, housing, leisure and culture, local food and other goods, public open space, social cohesion and local democracy, and transport (Badland et al., 2014). In another case on urban livability in India, objective indicators such as economic, social, household dimensions and accessibility, as well as subjective indicators such as satisfaction from the socio-economic environment and satisfaction from the physical and infrastructural environments were combined in the study (Saitluanga, 2013).

In addition, many organizations also focused on ranking globe livable cities using different evaluation criteria. For instance, the Economist Intelligence Unit's (EIU) Global Livability rankings incorporated 30 qualitative and quantitative indicators from 5 dimensions of stability, healthcare, culture and environment, education, and infrastructure (EIU, 2017), whereas the Merce's Quality of Living rated livability according to 39 factors grouped from 10 dimensions, including political and social environment, economic environment, socio-cultural environment, medical and health considerations, schools and education, public services and transportation, recreation, consumer goods, housing, and natural environment (Mercer, 2017). Despite ongoing debates about the measurement of urban livability in academic literature and organizations, their evaluation criteria were largely identical but with minor differences. In most cases, both physical environment and socio-cultural environment have been taken into consideration when evaluating the level of urban livability, including aspects of economic development, urban security, public facilities provision, traffic conditions, environment amenity, and socio-culture environment.

2.2. Determinants of residents' satisfaction with urban livability

The urban environment has been evaluated by both objective and subjective measurement methods in past literature. Notably, much objective research has emphasized the role of economic development in affecting the quality of the urban environment (Xu et al., 2012; Zanella, Camanho, & Dias, 2014). Despite the fact that economic factors could well support the construction of livable cities, economically developed cities tend to concurrently witness enormous pressure like high costs of housing and living, which in turn poses challenges to urban livability (Ogneva-Himmelberger et al., 2013). Consequently, this study is mainly concerned with the subjective evaluation of the urban environment based on residents' satisfaction with urban livability while overlooking economic benefits and other conceivable economic pressure. Conceptually, the determining factors affecting people's satisfaction with urban livability can be summarized in terms of the following aspects.

2.2.1. Urban security

Urban security is often considered as a prerequisite in shaping

livable urban environment (Tao, Wong, & Hui, 2014). This is not surprising since very few people are satisfied with the local urban environment without a sense of safety in their life and property. Previous studies have shown that satisfaction with the urban environment is associated with a range of factors in relation to urban security, such as crime rate (Ibem & Aduwo, 2013; Martínez, Short, & Ortíz, 2015), traffic safety (De Vos, Van Acker, & Witlox, 2016; Marans & Stimson, 2011), and emergency shelters (Yu & Wen, 2016). For instance, Buys and Miller (2012) explored the predictors of residential satisfaction in inner urban higher-density environments in Brisbane, Australia, and found that satisfaction with safety and the condition of the local area was one of the critical factors in predicting residential satisfaction. In another case study conducted in New Zealand by Fleming et al. (2016), variables like fear of crime were found to be negatively associated with life satisfaction in the ordered logit model.

2.2.2. Convenience of public facilities

Another important factor affecting people's satisfaction with the urban environment is the convenience of public facilities, which reflects urban residents' perceived access and quality of public facilities, such as facilities of shopping, education, healthcare, culture, entertainments and so on (De Vos et al., 2016). Due to the close relationship with urban quality of life, public facilities provision has been linked to residents' satisfaction with the urban environment in a large number of studies (Mohit et al., 2010; Tao et al., 2014). A study on residential satisfaction in Public Core Housing in Nigeria found that neighborhood facilities as well as housing unit characteristics, environment, and management and services contribute the most to predicting residential satisfaction (Ibem & Amole, 2012). In a similar study on the residential satisfaction of public housing in Hangzhou, China, it was observed that public facilities, neighborhood environment, and housing characteristics are the main factors influencing residential satisfaction (Huang & Du, 2015).

2.2.3. Environmental amenity

The increasingly important role of environmental amenity in affecting the quality of the urban environment has also been well recognized in much of the literature (Badland et al., 2014; Buys & Miller, 2012; Rehdanz & Maddison, 2008). Broadly speaking, environmental amenity consists of both wellbeing derived from the natural environment and environmental health (Rioux & Werner, 2011). The former generally encompasses favorable climate, access to parks and water areas, a green urban environment, and cleanliness (De Vos et al., 2016; Węziak-Białowolska, 2016), while the latter mainly emphasizes environmental pollution with respect to water, solid waste, ambient air as well as noise in the urban area (Saitluanga, 2013; Węziak-Białowolska, 2016). A study in Germany discussed the relationship between local environmental quality and life satisfaction and showed that higher levels of local air pollution and noise significantly diminish subjective wellbeing (Rehdanz & Maddison, 2008). By analyzing 2014 data from 44 U.S. cities, another study found that urban park quantity, quality, and accessibility are all positively associated with wellbeing (Larson, Jennings, & Cloutier, 2016).

2.2.4. Convenient transportation

Convenient transportation remains a significant predictor influencing people's satisfaction with the urban environment, especially in the metropolitan areas in China characterized by large populations (Ji & Gao, 2010; Tao et al., 2014; Zhang & Gao, 2008). It is evident that convenient transportation could contribute to urban dwellers' satisfaction with the urban environment by providing them with high mobility and saving them lots of travel time. Several typical features can be drawn from perceived transport-related convenience, including aspects of road conditions, access to public transit, availability of parking lots, and traffic congestion (Saitluanga, 2013; Zhang & Gao, 2008). For example, a study used survey data of the Berlin metropolitan area in Germany and found that access to public transportation is associated with better outcomes on all measures of health and wellbeing (Eibich et al., 2016). Another case study conducted on the newly designed low-cost public housing in Kuala Lumpur, Malaysia, suggested that satisfaction with perimeter roads as well as security services, cleanliness of garbage house, and garbage collection contributed most to predicting residential satisfaction (Mohit et al., 2010).

2.2.5. Sociocultural environment

In addition to physical environment factors, the social environment is also a crucial component of the urban environment that contributes to people's overall satisfaction. The social environment refers to the social setting where people live and includes community structures, resources, and policies that people create to order their lives (Salehi et al., 2017). Specially, the social environment of a city mainly includes a set of immaterial factors, such as high-quality citizens, social inclusion, urban identity, protection of historical culture, as well as a sense of belonging (Rostami et al., 2015). However, most of the previous studies have focused on the relationship between the sociocultural environment and satisfaction with the urban environment at the neighborhood level. Li and Wu (2013) suggested that lacking neighborhood social attachment significantly reduced residential satisfaction in China's informal settlements, whereas Sirgy and Cornwell (2002) indicated that social features of the neighborhood play a role in the satisfaction with the neighborhood and the community.

2.2.6. Individual socioeconomic attributes

Besides the social and physical dimensions of the urban environment discussed above, it has been shown that residents' individual socioeconomic attributes such as gender, age, education, income, and home ownership also affect their satisfaction with the urban environment (Campbell, Converse, & Rodgers, 1976; Lu, 1999). This is because that satisfaction with the urban environment is a subjective experience that involves psychological cognition and tends to differ among respondents. Seminal research using the American Housing Survey's national sample by Lu (1999) has shown that being older, white, homeowner, having higher incomes, living in more expensive homes are associated with more residential satisfaction. In the Chinese context, respondents who are young, female, highly educated, have small family size, married, homeowner, and with *hukou* in the city have higher levels of residential satisfaction (Lin & Li, 2017; Ren & Folmer, 2016; Zhang & Lu, 2016). However, the effects of individual socioeconomic attributes are often less consistent. For instance, some authors argued that home ownership does not necessarily improve residential satisfaction for low-income residents in Dalian, and being highly educated can decrease residential satisfaction (Chen et al., 2013). Thus, empirical studies on people's satisfaction with the urban environment focusing on specific places, groups of people and time may generate varying findings with respect to specific individual socioeconomic attributes (Mohit et al., 2010).

The literature review presented above shows that residents' satisfaction with urban livability is related to a series of factors. However, most studies have not depicted the satisfaction of urban livability of a country from the perspective of multiple cities and failed to address the effect intensity of the explanatory variables. Fig. 1 illustrates the conceptual framework of satisfaction with urban livability for this study. In line with the notion of the uncertain geographic context problem (UGCoP), the current study highlights that people's satisfaction with the urban environment is influenced by the satisfaction associated with the areas they are exposed to whey they undertake their daily activities and travel, which is experienced dynamically through various sites and times within the whole city as their daily life unfolds. In the conceptual framework, urban livability assessment involves six dimensions: urban security, the convenience of public facilities, the natural environment, the sociocultural environment, convenient transportation, and environmental health. Further, a person's overall satisfaction with urban livability is postulated to be associated not only with satisfaction with

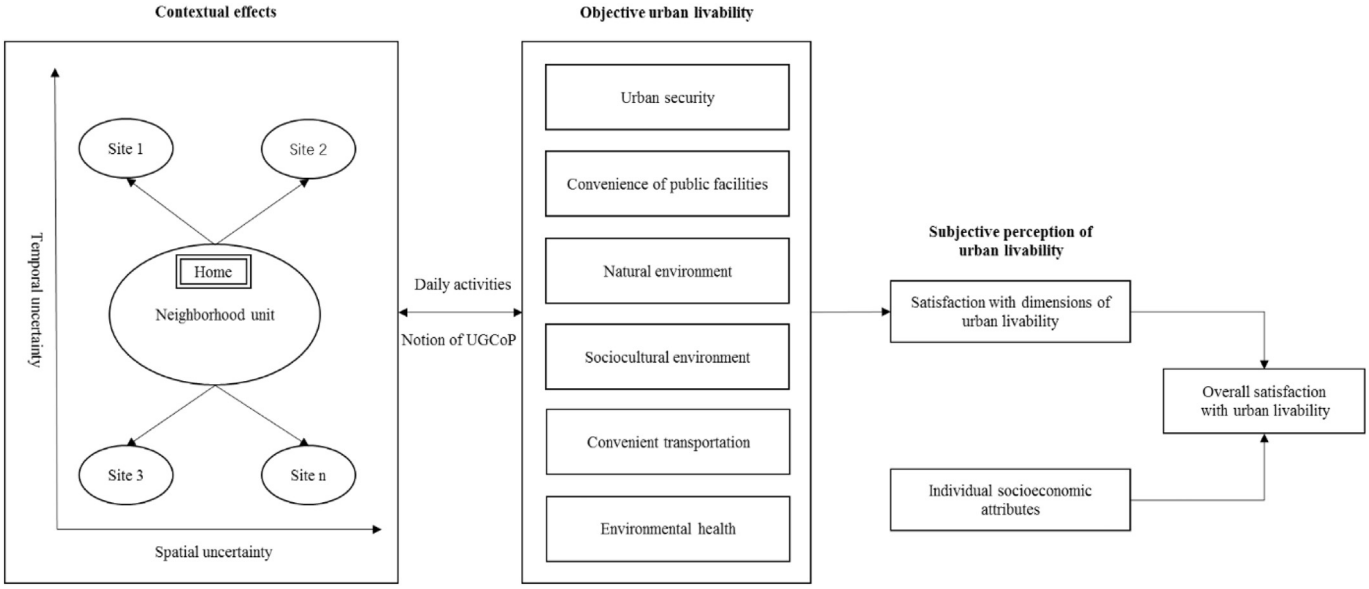

Fig. 1. Conceptual framework of satisfaction with urban livability.

the various dimensions of urban livability but also with individual socioeconomic attributes.

3. Methodology

3.1. Study area

As illustrated in Fig. 2, the study area for this research includes 40 major cities in China, including all the municipalities, provincial capital cities, sub-provincial cities and a few publicly recognized livable cities such as Weihai and Sanya. As shown in the figure, these cities are socio-economically developed and represent significant urban population clusters in China, with several demonstration examples of livable cities constructions. With respect to socio-economic characteristics, the 40 case cities accounted for 22.6% of the national population (0.31 billion people) and produced 43.1% of the total GDP (2.92 billion RMB) in 2015. More specifically, per capita GDP in 2015 ranged from 48,812 RMB in Nanning located in Guangxi Province, to 153,820 RMB in Shenzhen located in Guangdong province, indicating a clear trend of decline in economic status from the Eastern region to the Western region in China.

3.2. Data collection

Based on the above conceptual framework of urban livability assessment coupled with the distinctive cultural background in China, a new set of assessment indicators of satisfaction with urban livability in China was proposed in Table 1. The constructed assessment indicators comprise 29 indicators grouped into 6 dimensions: urban security, the convenience of public facilities, the natural environment, the socio-cultural environment, transportation convenience, and environmental health, which are also the main sections of the national urban livability survey.

The China urban livability survey, conducted by a professional marketing survey agency called Epanel (http://www.epanel.cn/), was launched and completed in May 2015 across the 40 selected cities in China. Combining random sampling and quota sampling methods, a total of 12,000 questionnaires were distributed to urban residents in the 40 case cities via both *E*-mail and website surveys, and 9325 valid questionnaires were obtained in the end (with a 77.7% effective rate). The valid sample size in each case city ranges from 220 to 250, which could be considered as being representative on the whole by comparing respondents' individual attributives with the local 2010 population census, despite a slight over-representation of highly educated residents due to the sampling methods. Evidence showing the survey data's representativeness of the urban population is available upon request.

During the investigation, survey respondents were asked how they are satisfied with each item regarding local urban livability according to their life experiences, whereas satisfaction with the six dimensions of urban livability was assessed using their corresponding items, and overall satisfaction with urban livability was further evaluated based on all the six sub-dimensions together. For each item, the responses were all measured on a five-point Likert Scale ranging from 1 for very dissatisfied to 5 for very satisfied. In addition, data on individual socio-economic characteristics of respondents were obtained in the survey, such as respondents' gender, age, education, occupation, monthly family income, family size, and *hukou*.

3.3. Methods

In this study, the geographical detector model was employed to examine the effect intensity of the factors affecting respondents' overall satisfaction with urban livability in China. The geographical detector model is a spatial variation analysis method first proposed by Wang et al. (2010), which has been widely used to identify the effect intensity of environmental factors on health outcomes. The basic idea of the model is to test the association between the explanatory variables and the dependent variable through the consistency of their spatial distribution. If the explanatory variables are closely associated with the dependent variable, their spatial distributions tend to be similar. Compared to traditional regression models, the geographical detector model is capable of handling categorical independent variables without consideration of the multicollinearity among the explanatory variables (Wang & Hu, 2012; Wang, Zhang, & Fu, 2016). The model consists of four components, including the factors detector, the risk detector, the ecological detector and the interaction detector. In this study, the factors detector was used to reveal the effect intensity of the influencing factors on respondents' overall satisfaction with urban livability. The factor detector model is as follows:

$$PD = 1 - \frac{1}{n\sigma^2}\sum_{h=1}^{L} n_h \sigma_h^2$$

where PD is the power of determinants, an index that is the same as effect intensity and ranges from 0 to 1. Specially, a PD value of 0 means

Fig. 2. The study case cities and their per capita GDP in 2015.

that little variance of the dependent variable is explained by the explanatory variables, where the total variance of the dependent variable is approaching the variance of the dependent variable in each subcategory of the explanatory variables (in other words, the dependent variable is likely to be randomly distributed in each subcategory of the explanatory variables). A PD value of 1 indicates that the variance of the dependent variable can be completely explained by explanatory variables, where the dependent variable tends to be the same without any variance within each subcategory of the explanatory variables. That is, the bigger the PD value, the greater the effect the explanatory variables have. n and o^2 stand for the sample size of the study population and variance of satisfaction with different dimensions of urban livability or different social groups. n_h and $\sigma_h{}^2$ refer to the sample size in each subcategory and its corresponding variance for satisfaction with urban livability.

4. Findings

4.1. Descriptive statistics of the study population

Table 2 lists the socio-economic characteristics of the survey respondents as well as their mean satisfaction with urban livability. Of the 9325 respondents, there were slightly more men (51.7%) than women (48.3%). The most reported age of the respondents was in the 30–39 range (27.1%), followed by 40–49 (19.9%) and 20–29 (18.6%). As for education, respondents with a degree above the undergraduate level were slightly over-represented (46.1% in total). Additionally, a majority of the respondents were in non-skilled occupations (65.9%), had an owner-occupied house (58.7%), and were local population (64.8%). As for family's monthly income, the most reported range was 5000–9999 RMB (29.0%), followed by10000–15,000 RMB (25.7%) and 3000–4999 RMB (19.6%). Family size of 3 persons has the largest percentage (32.6%), followed by 2 persons (24.0%), 4 persons (19.4%), and 5 persons and above (16.7%), while families with one person only accounted for a small percentage (7.3%). Moreover, more than half of the respondents (50.1%) were from the eastern region in China. The mean satisfaction with urban livability by socioeconomic characteristics listed here will be discussed in the following sections.

4.2. Characteristics of satisfaction with urban livability

Fig. 3 presents the mean satisfaction with respect to the six dimensions of urban security (A), the convenience of public facilities (B), the natural environment (C), the sociocultural environment (D), convenient transportation (E), and environmental health (F), as well as the overall assessment of urban livability. As shown in the figure, overall satisfaction with urban livability in the 40 Chinese cities has a mean of 2.996 ± 0.820SD, a level almost approaching the intermediate value 3, which indicates that the overall satisfaction with urban livability in China is moderate. Moreover, satisfaction level varies across the six dimensions of urban livability. The dimension with the highest satisfaction is the convenience of public facilities (3.118 ± 0.680SD), followed by the natural environment (3.057 ± 0.914SD) and the sociocultural environment (3.056 ± 0.872SD), while the dimensions

Table 1
Assessment indicators of satisfaction with urban livability in China.

Dimensions of urban livability	Assessment indicators
A. Urban security	A1 Social security
	A2 Transport security
	A3 Emergency shelters
	A4 Disaster response capacity
B. Convenience of public facilities	B1 Shopping facilities
	B2 Education facilities
	B3 Healthcare facilities
	B4 Dining facilities
	B5 Recreational facilities
	B6 Cultural facilities
	B7 Aged facilities
C. Natural environment	C1 Favorable climate
	C2 Access to water area
	C3 Access to urban parks
	C4 Urban green coverage rate
	C5 Cleanliness of city
D. Sociocultural environment	D1 High-quality citizens
	D2 Social inclusion
	D3 Urban identity
	D4 Protection of historical culture
	D5 Sense of belonging
E. Convenient transportation	E1 Urban road conditions
	E2 Access to public transit
	E3 Availability of parking lots
	E4 Traffic congestion
F. Environmental health	F1 Water pollution
	F2 Solid waste pollution
	F3 Air pollution
	F4 Noise pollution

with relatively low satisfaction pertain to urban security (2.788 ± 1.008SD), environmental health (2.912 ± 0.926SD) and convenient transportation (2.929 ± 0.825SD), whose scores are all below the overall satisfaction level. This finding suggests that the respondents are satisfied with the convenience of public facilities, the natural environment and the sociocultural environment, but are dissatisfied with urban security, environmental health and convenient transportation, whose satisfaction levels were all under the intermediate value. Moreover, the standard deviation further indicates that the advantage of the convenience of public facilities has been well recognized with the small standard variation, but urban security and environmental health on the contrary have big variation among the respondents.

Fig. 4 presents the mean satisfaction with respect to the 29 individual assessment indicators of urban livability. The result shows that the five highest levels of satisfaction with urban livability are mainly in the dimension of public facilities convenience, such as shopping facilities (3.175), dining facilities (3.173), education facilities (3.110), cultural facilities (3.105), in addition to a sense of belonging (3.103) in the sociocultural environment dimension. Conversely, the five lowest levels of satisfaction ranging from 2.820 to 2.924 are concentrated in the dimensions of environmental health and transportation convenience, including indicators of air pollution, availability of parking lots, noise pollution, traffic congestion, and water pollution. With respect to the dimensions of the natural environment and the sociocultural environment, satisfaction with most of their assessment indicators is moderate with a small score gap, ranging from 3.023 for access to water areas to 3.103 for a sense of belonging.

However, the assessment result in the dimension of urban security in Fig. 4 should be noted. Mean satisfaction levels of its assessment indicators in descending order are social security (3.088), disaster response capacity (3.023), emergency shelters (3.014) and transport security (2.940), which are higher than that of the dimensions of environmental health and convenient transportation. The finding may seem counterintuitive when compared to the lowest satisfaction with urban security. But this result may be explained by the possibility that most of the surveyed residents tend to take urban security as a priority, resulting in high expectations of urban security when evaluating their urban environment. As such, the respondents are more likely to feel more dissatisfied towards urban security due to situations such as the lack of emergency shelters construction, threats of traffic security, and other potential security risks in Chinese cities.

Table 2
Socioeconomic characteristics of the study population and their mean satisfaction with urban livability.

Attributes	Variables	Sample size	Percentage	Mean	SD
Gender	Female	4507	48.3%	2.986	0.815
	Male	4818	51.7%	3.005	0.825
Age	< 20	997	10.7%	3.027	0.861
	20–29	1734	18.6%	2.964	0.770
	30–39	2526	27.1%	3.035	0.798
	40–49	1856	19.9%	2.957	0.787
	50–59	1146	12.3%	3.000	0.891
	≥60	1066	11.4%	2.990	0.883
Education	Middle school and below	1046	11.2%	3.028	0.863
	High school	1720	18.4%	3.030	0.875
	College	2261	24.2%	2.967	0.809
	Undergraduate	2975	31.9%	3.025	0.807
	Master and above	1323	14.2%	2.911	0.751
Occupation	Non-skilled occupations	6143	65.9%	3.000	0.826
	Skill occupations	3182	34.1%	3.000	0.817
Family' month income	< 3000 RMB	1139	12.2%	2.947	0.799
	3000–4999 RMB	1826	19.6%	2.964	0.811
	5000–9999 RMB	2703	29.0%	3.024	0.825
	10,000–15,000 RMB	2392	25.7%	3.024	0.843
	15,000–20,000 RMB	617	6.6%	2.995	0.807
	20,000–30,000 RMB	484	5.2%	2.942	0.729
	> 30,000 RMB	164	1.8%	2.988	0.913
Housing type	Renting house	1975	21.2%	3.020	0.854
	Lodging house	829	8.9%	3.047	0.826
	Dorm	708	7.6%	2.846	0.760
	Public house without property right	335	3.6%	2.967	0.831
	Owner-occupied house	5478	58.7%	3.001	0.812
Family population	1 person	685	7.3%	2.902	0.793
	2 persons	2236	24.0%	2.971	0.814
	3 persons	3038	32.6%	3.034	0.826
	4 persons	1809	19.4%	2.987	0.818
	5 persons and above	1557	16.7%	3.010	0.828
Hukou	Floating population	3283	35.2%	3.033	0.855
	Local population	6042	64.8%	2.976	0.800
Geographical location	Eastern region	4675	50.1%	3.039	0.797
	Central region	1835	19.7%	2.925	0.852
	Western region	2815	30.2%	2.971	0.833

4.3. Determinants of overall satisfaction with urban livability

To identify the effect intensity of the factors that affect the overall satisfaction with urban livability in China, we employed the geographical detector model to explore the effect magnitude of the explanatory variables. In the model, the dependent variable was overall satisfaction with urban livability, whereas the explanatory variables were satisfaction with the six dimensions of urban livability and individual socioeconomic attributes. Table 3 shows the results of the power of determinants and their associated significance. The results indicate that all the dimensions of urban livability and some of the individual socioeconomic attributes are significantly associated with the overall satisfaction with urban livability in China, but the dimensions of urban livability have much greater effects on overall

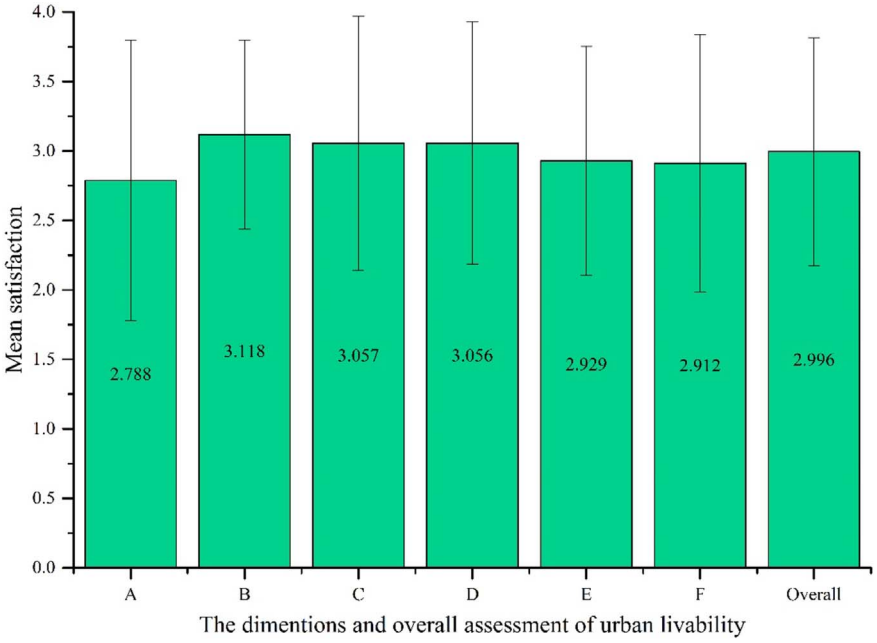

Fig. 3. Satisfaction with the dimensions and overall assessment of urban livability.

satisfaction relative to individual socioeconomic attributes.

With respect to the dimensions of urban livability, all the six dimensions are found to have a significant effect on the overall satisfaction with urban livability at the 0.01 significance level. Concerning these dimensions, the natural environment shows the strongest effect on the overall satisfaction with urban livability, explaining 9.75% of the variance of overall satisfaction with urban livability in the model, followed by convenient transportation (8.85%), environmental health (8.77%) and the sociocultural environment (8.68%). Contrarily, the dimensions of urban security and the convenience of public facilities appear to exert less effect on the overall satisfaction with urban livability, explaining 7.9% and 8.1% of the variance of overall satisfaction with urban livability respectively. In addition, Spearman correlation analysis was employed to identify the effect direction of the six dimensions of urban livability on overall satisfaction with urban livability. The results suggest that all the dimensions of urban livability are significantly and positively correlated with overall satisfaction, with correlation coefficients ranging from 0.250 to 0.277, indicating that higher levels of satisfaction with any dimensions of urban livability are associated with higher levels of overall satisfaction with urban livability.

In terms of individual socioeconomic attributes, six variables are found to be significantly associated with the overall satisfaction with urban livability, including respondents' geographical location, age, education, family size, *hukou* and housing type. Comparing the effect magnitude of the significant variables, the respondents' geographical location and housing type are found to have the greatest effect on their overall satisfaction with urban livability, which explains the same

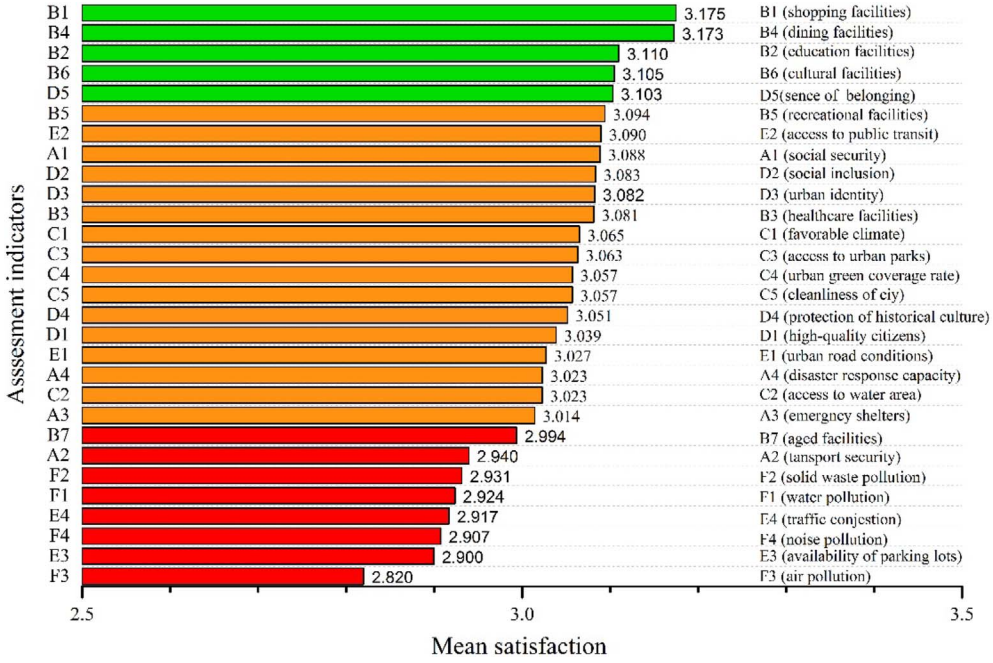

Fig. 4. Satisfaction with assessment indicators of urban livability.

Table 3
Geographical detector model result of overall satisfaction with urban livability.

Variables type	Explanatory variables	PD	*p*-Value	Effect direction
Dimensions of urban livability	Urban security	7.90%***	0.000	+
	Public facilities convenience	8.10%***	0.000	+
	Natural environment comfort	9.75%***	0.000	+
	Sociocultural environment comfort	8.68%***	0.000	+
	Convenient transportation	8.85%***	0.000	+
	Environment health	8.77%***	0.000	+
Individual socioeconomic attributes	Geographical location	0.31%***	0.000	−
	Gender	0.01%	0.255	Not significant
	Age	0.15%*	0.079	Non-linear
	Education	0.27%***	0.000	−
	Occupation	0.09%	0.987	Not significant
	Monthly family income	0.16%	0.656	Not significant
	Family size	0.19%**	0.022	+
	Hukou	0.11%***	0.009	−
	Housing type	0.31%*	0.079	Non-linear

Note: Dependent variable = overall satisfaction with urban livability; significance: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

variance of 0.31%, followed by education and family size, which explain 0.27% and 0.19% of the variance respectively. Moreover, *hukou* and age have much smaller effects on the overall satisfaction with urban livability, which explain 0.11% and 0.15% of the variance respectively. However, no significant association is found between the overall satisfaction with urban livability and some socioeconomic attributes variables, such as gender, occupation and monthly family income.

Based on the fifth and sixth columns in Table 2, individual socioeconomic attributes of statistical significance that have stronger relationships with satisfaction with urban livability was further examined. As shown, the respondents who live in the eastern region, lodging houses, rental housing as well as owner-occupied houses, with an undergraduate degree, with a high school and below degree, in households with 3 persons, 5 persons and above, who are part of the floating population, aged 30–39, < 20 and 50–59, were all found to be satisfied with urban livability, whose mean satisfaction level exceeds the intermediate value of 3. In addition, each variable in Column 2 of Table 2 was coded in ascending order by their attributes, and Spearman correlation analysis was used to identify the effect direction of individual socioeconomic attributes on satisfaction with urban livability. The results show that variables such as geographical location, education, and *hukou* have a weak negative correlation with satisfaction with urban livability, while family size has a positive effect. However, although age and housing type have a significant effect on satisfaction with urban livability, non-linear relationships are found between them in the Spearman correlation analysis.

5. Discussion and conclusions

Although there has been increasing public and governmental concern on urban livability in China in recent years, residents' satisfaction with urban livability in China is still understudied, especially at the national level. Based on the constructed urban livability assessment indicators and large-scale questionnaire surveys conducted in 2015 in 40 major cities in China, this study aimed to fill such knowledge gap by examining residents' satisfaction with urban livability and its determinants. The findings from this study not only add new evidence for policy making on livable cities construction in China, but contribute to the existing literature from at least two perspectives. First, different from traditional residential satisfaction research that focuses mainly on the residential neighborhood, this study — based on the notion of the uncertain geographic context problem (UGCoP) — developed a new conceptual framework and emphasized that people's perceived quality of the urban environment was associated with the areas they are exposed to as they undertake their daily activities and travel. These areas are experienced within the whole city and at different times of the day, and include many areas outside people's residential neighborhoods. Moreover, a novel analytical method (the geographical detector model) was used to examine and compare the effect intensity of the explanatory variables on overall satisfaction with urban livability, a significant concern for policy makers which has been neglected in much of the research.

The assessment results showed that the respondents had a mean satisfaction with urban livability of 2.996, which approaches the intermediate value of 3, implying a moderate satisfaction with urban livability in China. This finding is consistent with many other domestic and foreign research (Ibem & Amole, 2013; Mohit et al., 2010; Ren & Folmer, 2016; Tao et al., 2014), which also reported an intermediate level of satisfaction with local urban environment. One possible explanation is that with rapid economic development during the last three decades, urban livability in China has made certain progress in various aspects related to the urban environment and thus earned people's approbation. In terms of the six dimensions of urban livability, the respondents were a little more satisfied with the dimensions of the convenience of public facilities, the natural environment, the sociocultural environment, but are slightly dissatisfied with the dimensions of transportation convenience, environmental health, and urban security. These results seem to suggest that Chinese governments have put more emphasis on the speed of urban development that benefits public facilities convenience and the natural and sociocultural environments, but fail to address some urban sustainability issues, such as long-term transportation planning, environmental protection, and making adequate preparation against urban security risks (Chen, Lü, & Chen, 2016).

The results from the geographical detector model revealed that all the urban livability dimensions had a significant positive relationship with the overall satisfaction with urban livability, and the natural environment, transportation convenience, and environmental health contributed most to the overall satisfaction. The observed positive relationship appears to support the view proposed in many studies (Ibem & Amole, 2012; Lu, 1999; Mohit et al., 2010) that urban livability is a multi-dimensional construct of the urban environment, which highlights the importance of the comprehensive development in each dimension of urban livability. Additionally, the greatest effect intensity of the nature environment might be accounted for by the primary role that the natural environment plays in the perceived urban livability of urban residents in China; and defects in transportation convenience and environmental health are likely to reduce people's satisfaction with urban livability, which can explain their larger effect. However, the findings on which factor contributed most to the satisfaction with urban living environment tend to vary greatly from context to context for the

different surveyed residents and research methods used (Li & Wu, 2013; Mohit et al., 2010).

The magnitude of the individual socioeconomic attributes on satisfaction with urban livability was much smaller relative to the six urban livability dimensions. In descending order, they were geographical location, housing type, education, family size, *hukou*, and age. Among them, the respondents' geographical location, education and *hukou* had negative effects on their satisfaction with urban livability, which are supported by some recent studies (Gan et al., 2016) but partly contradict the finding by others (Huang & Du, 2015; Ren & Folmer, 2016). Compared with the central and western regions in China, the eastern region's higher levels of satisfaction can largely be attributed to its developed economy along with advantageous natural environment, and higher expectation towards urban environment among the educated residents and local population that is likely to decrease their satisfaction (Gan et al., 2016). Consistent with Chen et al. (2013), family size has a positive effect in this study, which may be explained by the closer social ties in the extended families in China. However, age and housing type were found to have non-linear relationships with satisfaction with urban livability. This finding with respect to age is acceptable since a U-shape relationship with residential satisfaction or individual wellbeing has frequently been reported in past studies (Blanchflower & Oswald, 2008). As for housing type, lower satisfaction with urban livability for residents who live in dormitories and public housing without property right also tends to suggest the positive effect of home ownership.

Findings in this paper have several important policy implications. First, to improve urban livability in China, Chinese governments should try to remedy the inadequacies in livability in several aspects, such as urban security, environmental health, and transportation convenience. Also, special efforts need to be devoted to addressing some specific issues, including various kinds of environmental pollution, availability of parking lots, traffic congestion, transport security, along with the lack of service facilities for the elderly. Second, despite the important role of urban security in urban livability, the most important factor in our study affecting overall satisfaction with urban livability is the natural environment, followed by transportation convenience and environmental health. Therefore, putting much investment into improving the natural environment cannot be overemphasized in the construction of livable cities in China, and the negative impacts of transportation inconvenience and environmental pollution on people's satisfaction with urban livability should also be appreciated by Chinese governments. Lastly, it is essential to encourage the participation of citizens with different socioeconomic attributes during the planning and construction process of livable cities, which could lead to a better understanding and consideration of local residents' different needs in the urban environment development process. From the regional point of view, livable cities construction in the central and western regions of China should be provided more support from the central government of China in order to enhance local satisfaction with urban livability.

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