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The effects of neighbourhood attachment and built environment on walking and life satisfaction: A case study of Shenzhen

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ABSTRACT

As the most sustainable mode of transport, walking enables people to interact with their environment more intimately. Such close interactions can strengthen pedestrians' place attachment and influence their life satisfaction and well-being. However, the bond between people and their meaningful places has been largely overlooked in walking studies. This study explores the effects of the built environment and neighbourhood attachment on the level of satisfaction for three purposes of walking trips and pedestrians' overall life satisfaction. Applying a mixed-methods design, surveys and semi-structured interviews were conducted to collect data from pedestrians in Shenzhen on their daily walking activities. Hierarchical regression analysis and qualitative thematic analysis were used to analyse the quantitative and qualitative data respectively. The findings suggested the effects of built environment on walking satisfaction vary among different purposes of walking, and neighbourhood attachment has significant positive effects on individual's walking satisfaction and life satisfaction. The qualitative findings further explained how neighbourhood attachment could modify individual's perceptions on walking environment and shaped their walking and life satisfaction through connecting pedestrians' feelings, memories, and knowledge of the neighbourhood to their walking experiences. This research extends the current debate on the links between the built environment, neighbourhood attachment and travel satisfaction.

1. Introduction

The emotional bond between individuals and their important places has long been considered as a powerful indicator for people's attitude, behavioural intention and actions (Devine-Wright, 2009; Halpenny, 2010). In the literature of environmental psychology, the significant role of place attachment in influencing people's behaviour and well-being has been well documented in the past two decades (Lewicka, 2011; Scannell & Gifford, 2017). It was reported that people with stronger attachment to their places of residence were more willing to engage in pro-environmental behaviour or activities on behalf of their places (Lewicka, 2011; Perkins et al., 1996). In the field of land use and transport studies, researchers have begun to consider the relationships between neighbourhood attachment, people's travel behaviour and well-being. For instance, pedestrians' attachment to the neighbourhood was found to mediate the effects between the built environment and walking intention and behaviour (Ferreira et al., 2016). Indeed, neighbourhood has been considered as the most optimal scale to study people's place attachment and behaviour (Lewicka, 2011), while the role of neighbourhood attachment in shaping people's walking behaviour and satisfaction is still largely overlooked in the extant studies. As the most sustainable mode of transport and a popular form of physical activity, walking enables people to experience and interact with places in a more direct and intimate manner (Ettema & Smajic, 2015; Wunderlich, 2008). On one hand, walking could nurture people's sense of place by facilitating them to foster affective, cognitive and social connections within their neighbourhood (Curl & Mason, 2019); on the other hand, people's attachment to neighbourhood may also shape their perceptions of the walking environment and result in more satisfactory trips or higher level of life satisfaction. As such, the concept of neighbourhood attachment has great potential to advance our knowledge about people's perceptions of the built environment, as well as the relationships between the built environment, walking and life satisfaction.

Moreover, much of the current research on the connections between the built environment and walking has focused on the behavioural dimension (just to name a few: Chan et al., 2019; Larrañaga et al., 2016; Kamruzzaman et al., 2016). Even among a few exceptions that examined people's satisfaction, the emphasis was placed on the effects of the built

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environment, travel attitudes on general level of travel satisfaction (De Vos & Witlox, 2017; Ye & Titheridge, 2017), rather than satisfaction for walking specifically. Given the specific nature of walking, people's daily walking activity could form a substantial portion of their life, and it is very likely that their sense of place and walking satisfaction can pose further impacts on life satisfaction (De Vos et al., 2013). Therefore, it is prominent to understand the ways through which pedestrians achieve higher level of walking and life satisfaction by looking at the connections between people's daily walking and their sense of place. In this study, we conceptualise walking satisfaction as pedestrians' own evaluation of their satisfaction level with a specific walking trip, as opposed to people's satisfaction with travel in general (De Vos & Witlox, 2017), and we use the concept life satisfaction to understand how individuals feel about their life as a whole as a cognitive judgement of people's subjective well-being (Kahneman & Krueger, 2006; Li & Chan, 2020, 2021).

This study considers three specific purposes of walking trips (walking for work/school, leisure/recreation and household responsibilities) in exploring the impacts of built environment and neighbourhood attachment on walking and life satisfaction. Pedestrians' experiences and practices of walking trips are likely to be different due to the diversified nature and flexibility of various trip purposes (Vilhelmson, 1999). For instance, people with stronger neighbourhood attachment may perceive their built environment as more favourable for leisure trips and activities, and consequently conduct more physical activity and obtain a higher level of walking satisfaction, and even overall life satisfaction (Oswald et al., 2011). However, such effects on other purposes of walking might not be the same and deserve further investigation. Therefore, examining walking satisfaction with specific purposes of walking trips can provide more specific understanding of the connections between neighbourhood attachment, built environment, and purpose-specific walking satisfaction.

Based on these considerations, this study aims to investigate the links between built environment and walking and life satisfaction by incorporating the concept of neighbourhood attachment. By drawing upon socio-ecological framework and place attachment (PPP) model, we adopted a mixed-methods design using a fast-developed urban context Shenzhen as a case. We seek to answer two research questions: 1) What are the effects of socio-demographic, built environment and neighbourhood attachment on walking satisfaction and life satisfaction? 2) In what ways do neighbourhood attachment affect pedestrians' walking satisfaction and satisfaction with life? To answer these questions, we first applied quantitative method to examine the relationships of socio-demographics, environmental perceptions and neighbourhood attachment on walking satisfaction and life satisfaction respectively using hierarchical regression analyses. Next, a qualitative research was conducted using semi-structure interview and thematic analysis to explain the possible pathways and mechanisms that connect pedestrians' attachment, perceptions of the built environment, their walking and life satisfaction.

2. Literature review

2.1. Significance of considering travel satisfaction

In the past two decades, transportation researchers have largely focused on understanding the factors that shape people's travel decisions; while less attention has been paid to people's experience during their trips (Ettema et al., 2013; Silva et al., 2021). This may be because researchers have usually assumed that the utility derived from people's travel choices (e.g. through discrete choice models) is equivalent to the experienced utility generated during their trips[1] (De Vos & Witlox, 2017; Ettema et al., 2013). Satisfied experience can not only improve traveller's experienced utility, it can also have positive effects on people's attitudes and intentions, which may increase the chance of choosing the same travel options in the future (Abou-Zeid & Ben-Akiva, 2012; De Vos, 2019). Therefore, it will be critical to investigate travel satisfaction and the factors that contribute to a higher satisfaction level in order to design better services, infrastructures and environment.

In existing travel satisfaction literature, it is generally observed that travellers that make use of active modes (walking and cycling) report higher levels of satisfaction compared to users of motorized modes (De Vos et al., 2016; Lades et al., 2020; Morris & Guerra, 2015). Using the Satisfaction with Travel Scales and cognate measures, previous studies have found that good weather conditions, higher level of environmental awareness and better quality of the walking environment (including pavement condition, aesthetics qualities, and safety) were associated with higher level of satisfaction (Alfonzo, 2005; Stradling et al., 2007). While other studies revealed that longer trip durations (Manaugh & El-Geneidy, 2013) and traveling alone (Lancée et al., 2017; Zhu & Fan, 2018) were associated with lower level of satisfaction. However, other factors beyond the built environment and walking attitudes that influence different types of walking satisfaction are still uncertain.

The socio-ecological framework that highlights the complex interrelationships between human behaviour and the environmental influences (natural, social, physical) at various scales (intrapersonal, interpersonal, and institutional), provides the theoretical foundation for researchers to examine the multiple levels of influences on people's travel behaviour (Richard et al., 2011; Sallis et al., 1998). Previous studies have classified the distinct levels of influence into macro, *meso*, and micro levels. For instance, the built and policy environment were considered as the macro scale of influence, while the community, social, and cultural environmental factors were regarded as meso scale influences; intrapersonal or individual factors were considered at the micro level (Götschi et al., 2017; Sallis et al., 2006). More recently, a growing number of studies started to move beyond the focus of macro scale factors (e.g. the built environment) and attend to the role of micro scale factors, e.g. psychosocial factors in influencing people's travel satisfaction (Verhoeven et al., 2016; Ye & Titheridge, 2017). Factors such as individuals' perceptions, attitudes, preferences, habit and social norms can help to explain why individuals with similar socio-demographic characteristics have different travel behaviours and level of satisfaction (De Vos & Witlox, 2017; Van Acker et al., 2010). Following these insights, a few recent studies begin to highlight that pedestrians have their unique preferences and interpretations of the walking environment, and their experiences during walking trips are highly personalised depending on their interactions with place, time and meanings (Bornioli et al., 2019; Chan et al., 2020). Although this strand of studies has offered fruitful insights in revealing major factors that contribute to more satisfied walking experience, how pedestrians' neighbourhood attachment experienced during their travel affect the level of walking satisfaction have rarely been examined. More in-depth examination is urgently needed to look into the role of neighbourhood attachment in shaping people's walking experience.

2.2. Walking and place attachment

Since the 1970s, the concepts of place and place attachment have become the focus in understanding the connections between people and their environments. Tuan (1975) illustrated how sense of place can be developed from people's every day experiences through their spatial aspirations, dependence and attachments. Meanwhile, Relph (1976)

[1] Experienced utility refers to the experience of feelings and emotions, which is different from the concept of decision utility – the utility associated with the prospective choice of an alternative.

identified three components of place from the examinations of human situations, events, meanings and experiences in everyday life: physical setting, activities and meanings. Based upon their conceptualisations, researchers argued that place should be understood in terms of how people experienced and interpreted it rather than just described its physical settings (Seamon & Sowers, 2008). The concept of place (and place attachment) provided us an innovative lens to deepen our understandings of the connections between pedestrians and the environment. As it is argued that it is not only the objective characteristics of the built environment that are important in shaping people's behaviour and experiences, but how individuals evaluate these environmental features subjectively. Following this idea, place attachment has been demonstrated to be a potentially important factor in shaping how people perceive the environment and influence their behaviour.

In fact, the concept of place attachment is highly relevant to walking experience and satisfaction. As pedestrians are usually more exposed to and have direct interactions with the surrounding environment during their walking trips compared to other modes of transport, this direct contact provides an opportunity for pedestrians to establish intense personal connections, construct understandings, and generate place attachments and meanings associated with the environment (Givoni & Banister, 2010; Ingold, 2007). In this sense, walking offers an embodied basis to experience and engage with the world (Rybråten et al., 2019), and allow the development of emotional bonds through their interactions with the physical surroundings (Manzo & Devine-Wright, 2013). Given that most of the daily walking activities were performed at very localised scale – at and around pedestrians' residential neighbourhoods, therefore, neighbourhood seems to be an optimal level of abstraction to study people's connection to the environment, especially in relation to walking activities (Lewicka, 2011).

Place attachment and its cognate concepts, such as neighbourhood/community attachment (Kwon et al., 2017; Van Cauwenberg et al., 2014; Wilkie & Clements, 2018), sense of place/community (Masterson et al., 2017; Wunderlich, 2008) and emotional bonding (Ferreira et al., 2016), have been used by scholars to indicate the connections between people and place. As one of the many important psychosocial factors (or refers to the micro scale factors in the socio-ecological framework) that are potentially important in explaining the connections between the environment and people's travel behaviour and experience, the concept of place attachment, and the PPP framework (person, place and process) (Scannell & Gifford, 2010) provides useful insights for us to further understand the connections between people's emotional connections with the environment and their travel. Nonetheless, the concept of place or neighbourhood attachment have received limited attention in the transport literature to date, with only a few notable exceptions, for instance, Ferreira et al. (2016) examined the relationships between perceived neighbourhood qualities and walking (intentions and behaviour) and found that the effects of qualities of the built environment was partially mediated by pedestrians' emotional relationship (neighbourhood attachment and affective dimensions) to the neighbourhood. In addition, previous studies have also demonstrated perceived built environment have positive influence on community attachment (Jun & Hur, 2015). However, the relationships between the built environment, neighbourhood attachment, and walking satisfaction are still largely unclear and thus deserve further exploration.

2.3. The built environment, travel and life satisfaction

The concept of life satisfaction, sometimes being used interchangeably with other concepts, such as quality of life and well-being, has attracted growing attention in academia in the past decade. Life satisfaction is considered as a major construct for assessing people's cognitive judgement of their life as a whole, and it consists of the satisfaction level of different life domains, including self, work, leisure, family, and environment (Bond et al., 2012).

Travel satisfaction as a major component of people's daily experience, has been hypothesised to affect life satisfaction (Olsson et al., 2020; Waygood et al., 2019). Positive travel experience can improve people's life satisfaction through improving their mood during travel and fulfilling their daily activities (De Vos & Witlox, 2017; Nordbakke & Schwanen, 2014). For instance, travel to visit friends and family (Dolan et al., 2008), conduct religious and volunteering activities (Morris & Guerra, 2015), and travel for leisure activities (Schmiedeberg & Schröder, 2017) are all revealed to have association with higher life satisfaction. Previous studies also suggested that correlations exist between physical exercise and life satisfaction, and active travel such as walking and cycling may also contribute to people's life satisfaction (Park, 2004). Apart from travel, built environment features of people's residence are also found to have impacts on their life satisfaction. For example, public greenspaces (Ambrey & Fleming, 2014), urban greenways (Shafer et al., 2000), and neighbourhood open spaces (Sugiyama et al., 2009) were found to have positive effects on life satisfaction. Positive effects were also highlighted between perceived built environment and life satisfaction, including perceived safety and pleasantness (Sugiyama et al., 2009), perceived neighbourhood characteristics and cohesion (Friedman et al., 2012), and perceived accessibility (Pfeiffer et al., 2020). These studies have provided important insights explaining the connections between travel experience, the built environment and life satisfaction.

However, there are still significant gaps in the literature. Firstly, most of these studies have either explored the effects of travel or built environment on life satisfaction, and only a few studies have examined these factors simultaneously. One of the notable exceptions is the study by McCarthy and Habib (2018), which used probit models and survey data from Canada to examine the effects of travel and the built environment on life satisfaction. They concluded that being physically active, living closer to park or sports field, having access to various transportation options, and being community-minded are positively associated with life satisfaction. Secondly, much research has focused on people's travel behaviour and travel satisfaction in general, while travellers' satisfaction with specific transport modes such as walking, and their personal interpretation of the connections with the neighbourhood have rarely been taken into consideration. Therefore, it is timely to incorporate the concept of neighbourhood attachment and attend to the pedestrians' own narratives to explore the potential pathways that connects the built environment, walking and life satisfaction.

3. Research design and methodology

This study is part of a larger research project that applied sequential mixed-methods design to examine the connections between built environment, walking, and well-being, using data collected from semi-structured interviews, surveys and environmental audit. Drawing insights from the socio-ecological framework and the concept of place attachment, this paper reports findings from the semi-structured interviews and surveys, focusing specifically on the understanding the relationships between neighbourhood attachment, walking and life satisfaction.

3.1. Research setting

As one of the most densely populated cities in south China, Shenzhen has witnessed rapid and profound changes in its urban and economic structure since the Open-Door Policy in the 1979. Economic reforms sparkled rapid urbanisation within the Shenzhen Special Economic Zones (SEZ), it was not until the past two decades that more developments gradually spread towards districts outside the SEZ. This resulted in highly uneven distribution of developments and neighbourhoods with different characteristics and levels of walkability (Chan et al., 2021). To capture such variations, a multi-stage sampling method was applied for neighbourhood selection. First, two sub-districts, one located in the inner urban area (Shatou) and another in the outer urban

area (Longchen) were selected because of their differences in regional accessibility. Next, using data from Baidu Map, two neighbourhoods with the highest and lowest local accessibility (measured with a composite index capturing: 1. distance to nearest metro station; 2. distance to the nearest park or plaza; 3. number of restaurants within the neighbourhood boundary) were selected for this study. The selected neighbourhoods were: Xinzhou (Inner-high), Xinsha (Inner-low), Shangjing (Outer-high), Huilongpu (Outer-low). The details of the neighbourhood selection process are discussed in another companion paper (Chan et al., 2019).

3.2. Data sources and analysis

A mixed-methods design was applied in this study. The advantages of mixed-methods studies are increasingly recognised in urban and transport research, for instance, integrating multiple sources of data can help to generate novel insights and multifaceted understanding of complicated research topics, allow the triangulation of findings to improve robustness, and explore the potential causal mechanisms of relationships (Næss, 2018; Tiznado-Aitken et al., 2020). Thus, integrating the use of qualitative inquiry and quantitative method in design enabled us to obtain a more refined picture of the interrelationships between place, environment, and satisfaction. Qualitative and quantitative data were collected in two phases, from November 2015 to February 2016 and December 2016 to March 2017 respectively, to allow the partial analysis of the data collected in the first phase to inform the subsequent design and data collection in the second phase. Importantly, the ethical approval was obtained from the Central University Research Ethics Committee (CUREC) of University of Oxford before the data collection phases to ensure the researchers follow all steps and university guidelines regarding ethical issues. For instance, both verbal and written consents were obtained from our participants before the survey and interviews respectively; the interviewers and surveyors were equipped with knowledge and skills which allow them to better communicate with the participants regarding the project purpose, the usage of the collected data, as well as their identity and privacy. We ensure that data would be anonymized to protect the confidentiality of the participants.

3.2.1. Quantitative data

3.2.1.1. Survey design. This survey belongs to a larger project examining respondents' walking behaviour and experience, environmental perceptions and well-being. In this study, variables relating to respondents' walking satisfaction and life satisfaction, environmental perceptions, neighbourhood attachment, and socio-demographic characteristics were used.

Walking satisfaction was measured by the Satisfaction with Travel Scale (STS) developed by Ettema et al. (2011). Respondents were asked to indicate their feelings and emotions of walking trips for three specific purposes (school/work, leisure/recreation, and household responsibilities) that they performed most recently.[2] Nine items capturing both affective and cognitive components of travel experience were included: "bored – enthusiastic", "fed up – engaged", "tired – alert", "stressed – calm", "worried – confident", "hurried – relaxed", "travel was worst I can think of – travel was best I can think of", "travel was low standard – travel was high standard", and "travel did not work out well – travel worked out well". Respondents were asked to indicate how they experienced that walking trip on 7-point scales, ranging from 1 (minimum) to 7 (maximum).

Life satisfaction was measured by the Satisfaction with Life Scale (Diener et al., 1985), which was developed to measure specifically the judgmental component of subjective well-being (Pavot et al., 1991). Respondents indicate whether they agree with five statements, "In most ways my life is close to my ideal", "The conditions of my life are excellent", "I am satisfied with my life", "So far I have gotten the important things I want in life", and "If I could live my life over, I would change almost nothing", using a 7-pint Likert scale from 1 (strongly disagree) to 7 (strongly agree). The summation of the scores of all five statements was used to assess their level of life satisfaction.

Built environment variables were measured using items modified from the abbreviated version of the Neighbourhood Environment Walkability Scale (NEWS-A) (Cerin et al., 2009), respondents were asked whether they agree with 29 statements regarding their neighbourhood environment, with a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). These items measure eight aspects of environmental perceptions, in which five of them were positive (higher the better), including access to destinations, street network, physical infrastructure, aesthetics and maintenance and upkeep. Three of them were negative (lower the better), including traffic safety, personal safety, and poor footpath condition. The average scores of these items were used to assess the built environment. Detailed information about the statements used to measure environmental perceptions can be found in a companion paper (Chan et al., 2019).

Neighbourhood attachment was measured by the Neighbourhood Attachment Scale (Fornara et al., 2010). Respondents need to indicate the degree that they agree with four statements, "This neighbourhood is part of me", "It would be very hard for me to leave this neighbourhood", "This is the ideal neighbourhood for me", and "I do not feel integrated in this neighbourhood",[3] using a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The average scores of these four statements were used to assess the level of neighbourhood attachment.

Neighbourhood characteristics were measured with two dummy variables to indicate whether the neighbourhoods are inner urban neighbourhoods and neighbourhoods with high local accessibility.[4]

Socio-demographic variables, including: age, gender, employment status, household income, length of residency in the neighbourhood and Body Mass Index (BMI) were also collected.

3.2.1.2. Survey administration and sampling. Quantitative data was collected by intercept surveys administered in the selected neighbourhoods in Shenzhen with the assistance of trained surveyors. Street intercept survey is an effective and efficient recruitment method, in which response rate and response bias could be assessed and closely monitored. Individuals who were not from the studied neighbourhoods can be excluded and "in-time" data about their travel behaviour can be collected. This method is indeed providing closer monitor to the whole data collection process as well as the quality of the data. However, intercept studies, on the other hand, may also have some limitations, such as lower response rates as potential participants do not want to be delayed from their daily activities. The study is limited to Shenzhen residents who are over 18 years old and are currently living in the selected neighbourhoods during the time of participating in the surveys. Because of the neighbourhood-based study design, a combination of convenience sampling (all adults available in the public spaces) and random probability sampling (surveyors were instructed to approach the next adult they encounter as a potential respondents) was applied for participant recruitment (Chan et al., 2019). Two screening questions were asked to confirm the participants' age and place of residence before the start of the survey. A pilot study was conducted ($N = 30$) to test the feasibility of the survey before the main study. This pilot test provided useful insights that allow the authors to revise the survey, including

[2] In the existing literature, travel satisfaction can be measured either by satisfaction with specific trip (trip satisfaction) or satisfaction with travel in general (satisfaction with daily travel). In this study, we focus on satisfaction of walking trips for specific purposes, so we asked respondents to recall their satisfaction of walking trips that they performed most recently.

[3] Reverse scored item.

[4] Please refer to Section 3.1 regarding the neighbourhood selection process.

reduce the number of measurement items for some of the chosen scales, rearrange the order of questions, and test the validity of the survey questions. The surveys were conducted in multiple locations within the neighbourhoods on both weekdays and weekends in order to recruit all types of residents in the sample. Respondents were provided with a small gift (about USD$1) as an incentive for their participation. In total, 890 surveys were collected. After excluding incomplete surveys based on a listwise deletion process, a final sample of 730 cases were used for data analysis (Kang, 2013). Power analysis was conducted for multiple regression analysis with 15 predictor variables with an effect size of 0.1, significance level at $\alpha = 0.05$ (two-tailed), and a power of 0.80. A minimum sample size of 183 was obtained. This confirms that the final sample size (730) is adequate for the multiple regression analyses.

Data analysis was conducted using STATA 14.0. Firstly, a series of hierarchical regression models were constructed to examine the effects of the independent variables on walking satisfaction and life satisfaction respectively. Hierarchical multiple regression was used as it allows predictor variables to be entered the model in "blocks", which enables the researcher to determine the model improvements with the addition of new predictor variables (Cohen et al., 2013). Socio-demographic factors and neighbourhood characteristics were first added to the model, and then the built environment variables, and neighbourhood attachment was added in the final models. To account for the clustered nature of data (respondents are nested within neighbourhoods), regression models with clustered standard errors were used to ensure the standard errors are not underestimated.[5] For all the models presented, multicollinearity and independence of errors are checked to ensure the assumptions of linear regressions are met.

3.2.2. Qualitative data

Qualitative data was collected through semi-structured interviews with residents who were residing in Shenzhen and conducted any type (s) of walking trips at least 2 times per week. The aim of qualitative interviews was to discover salient personal and contextual factors associated with participants' walking and life experiences and their relationships with their neighbourhood. Thus, rather than to generalise the findings from a statistically representative sample, we sought to reach pedestrians with diversified personal background, walking purposes and experiences and explore more deeply the underlying mechanisms hidden in their daily practices. Snowball sampling method was adopted to recruit participants and an inductive approach was used to extract significant themes from participants' personal life stories, particularly feelings, perceptions and meanings of walking in their neighbourhood environment. A set of open-ended questions about neighbourhood characteristics, built environment and walking experience were prepared to guide the interviews. These questions were carefully tested and modified through a pilot test with two Shenzhen residents before the main study. In total, 20 in-depth interviews were conducted, and each lasted from 60 to 90 min. All interviews were conducted in either public space or other locale the participants found convenient and comfortable, in Mandarin or Cantonese, and were audio-recorded after obtaining interviewees' consent. Interviews were translated into English and transcribed afterwards. Data saturation was assessed through the counting of occurrences of themes related to our topic and their meanings and importance (Hennink et al., 2017). Data saturation was achieved when no new relevant themes emerged from the new interviews (Guest et al., 2006).

Thematic analysis was applied to analyse the qualitative data iteratively (Braun & Clarke, 2006). First, open coding was used to assign initial codes to the respondents' narratives (Strauss & Corbin, 1998). The aim of this stage was to identify pathways and themes that connect people's neighbourhood attachment, walking experience and life satisfaction. In the second stage, the authors went further to compare and link these themes and pathways across cases. We focused more on evaluating these potential connections across different cases and organising these narrations under respective themes. The third stage concerned the modification and finalisation of themes. We conducted several rounds of discussions comparing the identified themes, linkages and explanations to ensure the consistency and reliability (Boyatzis, 1998). Any discrepancies were resolved during this stage until a final agreement of presentation was achieved.

4. Findings

4.1. Quantitative results

4.1.1. Descriptive statistics

Tables 1 and 2 show the socio-demographic characteristics of the respondents and descriptive statistics of the variables respectively. More than half of the respondents were between 18 and 40 years old and there are slightly more female (56.7 %) compared to male respondents (43.3 %). Most respondents (46.4 %) had been living in their current neighbourhood for 2–5 years. There are slightly more respondents (58.5 %) that are not full-time employed. In terms of body mass index (BMI), most of the respondents (76.9 %) have a BMI lower than 25. Table 2 shows the Cronbach alpha for all the variables were sufficiently reliable. The correlations for the major variables used in the models were provided in Appendix 1.

4.1.2. Walking satisfaction

Three separate hierarchical regression models were used to examine the effects of socio-demographic characteristics, environmental perceptions and neighbourhood attachment on the level of satisfaction for three specific purposes of walking, namely walking for work/school, for leisure/recreation, and for household responsibilities.[6]

4.1.2.1. Walking satisfaction for work/school. The base model (1a) is

Table 1
Descriptive statistics of socio-demographic variables.

Variables	Categories	Sample	Percentage
Age	18–30	182	24.9 %
	31–40	191	26.2 %
	41–50	120	16.4 %
	51–60	133	18.2 %
	Over 60	104	14.2 %
Gender	Male	316	43.3 %
	Female	414	56.7 %
Employment	Full-time	303	41.5 %
	Not full-time	427	58.5 %
Household income (CNY)	<100,000	260	39.7 %
	100,000 to 300,000	325	49.6 %
	>300,000	70	10.7 %
Length of residency	<2 years	107	14.7 %
	2–5 years	337	46.4 %
	6–10 years	205	28.2 %
	>10 years	78	10.7 %
Body Mass Index (BMI)	<18.5	54	7.5 %
	18.5–24.9	499	69.4 %
	25.0–29.9	148	20.6 %
	>30.0	18	2.5 %

[5] Clustered standard error and hierarchical linear models can also be used for this type of analysis, but hierarchical linear models pay more attention to the interactions between different levels of the data structure, which is beyond the scope of this paper. So, regression with clustered standard error was used in this study.

[6] Due to the use of regression with clustered standard error, only unstandardized coefficients were reported in the regression analyses (Tables 3 to 6).

Table 2
Descriptive statistics of variables.

Type	Variables	Mean (s.d.)	Cronbach's alpha
Life satisfaction	• Satisfaction with Life Scale (5–35)	24.23 (5.66)	0.886
Walking satisfaction	• Satisfaction of walking for work/school (1–7)	4.82 (0.97)	0.904
	• Satisfaction of walking for leisure/recreation (1–7)	5.59 (1.04)	0.944
	• Satisfaction of walking for household responsibilities (1–7)	5.20 (0.90)	0.925
Built environment variables	• Access to destinations (1–5)	3.69 (0.54)	0.692
	• Street network (1–5)	3.54 (0.66)	0.680
	• Physical infrastructure (1–5)	3.61 (0.68)	0.693
	• Aesthetics (1–5)	3.38 (0.68)	0.718
	• Maintenance and upkeep (1–5)	3.30 (0.72)	0.799
	• Traffic safety (1–5)	2.77 (0.75)	0.667
	• Personal safety (1–5)	2.72 (0.84)	0.752
	• Poor footpath condition (1–5)	2.84 (0.67)	0.707
Neighbourhood characteristics	• Inner urban neighbourhood (0/1)	0.48 (0.50)	n/a
	• High local accessibility neighbourhood (0/1)	0.51 (0.50)	n/a
Neighbourhood attachment	• Neighbourhood attachment (1–5)	3.23 (0.81)	0.794

significant with an R^2 of 0.071 (as shown in Table 3). The low explanatory power of this model is similar to other studies on travel satisfaction (Ettema et al., 2017; Mouratidis et al., 2019) and is reasonable when only socio-demographic variables were considered. It is found that respondents who have been living in their neighbourhood longer have higher satisfaction towards their walking trips for work/school. In addition, respondents living in high accessibility neighbourhoods are also more satisfied. In the next model (1b), adding the environmental perceptions variables increase the model's R^2 to 0.163. It is observed that personal safety is significant but have negative effects on walking satisfaction. This finding coincides with our expectation; it is because when the walking environment is perceived as unsafe, it is more likely to create poor pedestrian experience during their walking trips and hence lower their satisfaction (Hong & Chen, 2014). Poor footpath condition is also significant, but only at 0.1 level, and also demonstrated negative effects on walking satisfaction. Neighbourhood attachment was added in the third model (1c), but it is not significant and has no effect on the explanatory power of the model.

4.1.2.2. Walking satisfaction for leisure/recreation. For leisure and recreational walking, the base model (2a) has a R^2 of 0.154 (as shown in Table 4), which is higher than the model of walking for work/school (Model 1a), and more socio-demographic variables are associated with walking satisfaction. For instance, age is found to be negatively associated with walking satisfaction for leisure and recreation trips, especially for the younger age groups (<40 years old). In addition, pedestrians who are normal or healthy weighted (BMI 18.5–24.9) have better walking satisfaction for their leisure and recreation trips. In the next model (2b), after adding the environmental perception variables, the R^2 increased by 0.082 to 0.236. As expected, traffic safety has negative influences on walking satisfaction, and other environmental perceptions variables are only significant at the 0.1 level, including aesthetics and street network, both have positive effects on walking satisfaction. Adding the neighbourhood attachment variable to the third model (2c) increased the R^2 to 0.276 (increase by 0.04), showing neighbourhood attachment has positive influence on walking satisfaction for leisure and recreation, but inclusion of this variable lowered the level of significance of other environmental perception variables.

4.1.2.3. Walking satisfaction for household responsibilities. For walking related to household responsibilities, the R^2 of base model (3a) is 0.1 (as shown in Table 5), showing socio-demographic variables only explained 10 % of the variance. Among the socio-demographic variables, only age is significant, but with negative influence on walking satisfaction for household responsibilities, especially for the younger adults (18–30 years old). The two neighbourhood characteristics variables are also significant and have positive effects on the level of satisfaction for household

Table 3
Linear regression models on satisfaction of walking for work/school.

	Model 1a	Model 1b	Model 1c
	B (SE)	B (SE)	B (SE)
Constant	5.091 (0.693) ***	5.199 (0.599) ***	5.113 (0.738) ***
Socio-demographic variables			
Age			
18–30	−0.700 (0.569)	−0.700 (0.588)	−0.700 (0.589)
31–40	−0.796 (0.695)	−0.843 (0.628)	−0.845 (0.626)
41–50	−0.665 (0.613)	−0.752 (0.576)	−0.751 (0.579)
51–60	−0.634 (0.572)	−0.537 (0.611)	−0.537 (0.612)
Male	−0.004 (0.123)	0.019 (0.096)	0.016 (0.095)
Full-time employed	−0.635 (0.076)	0.011 (0.036)	0.015 (0.036)
Length of residency			
2–5 years	0.171 (0.018) ***	0.152 (0.044)**	0.154 (0.043)**
6–10 years	0.198 (0.076)*	0.149 (0.060)*	0.147 (0.051)*
>10 years	0.485 (0.112) **	0.288 (0.110)*	0.285 (0.109)*
Income			
100,001 to 300,000	0.136 (0.076)	0.087 (0.080)	0.088 (0.078)
Over 300,001	0.246 (0.152)	0.116 (0.136)	0.115 (0.137)
BMI			
<18.5	0.234 (0.183)	0.259 (0.126)	0.262 (0.132)
18.5–24.9	0.198 (0.106)	0.175 (0.069)*	0.174 (0.069)*
Neighbourhood characteristics			
Inner urban	−0.046 (0.036)	−0.083 (0.024) **	−0.091 (0.030) *
High accessibility	0.228 (0.010) ***	0.156 (0.066)*	0.156 (0.066)*
Built environment variables			
Access to destinations		0.103 (0.140)	0.103 (0.140)
Aesthetics		0.033 (0.056)	0.027 (0.048)
Street network		−0.019 (0.071)	−0.020 (0.069)
Physical infrastructure		0.086 (0.088)	0.086 (0.085)
Maintenance and upkeep		0.091 (0.173)	0.085 (0.162)
Traffic safety		0.019 (0.083)	0.021 (0.087)
Personal safety		−0.096 (0.029) **	−0.096 (0.029) **
Poor footpath condition		−0.230 (0.089) *	−0.228 (0.088) *
Neighbourhood attachment			0.028 (0.070)
Sample size	410	410	410
R^2	0.071	0.163	0.164
Changes in R^2		0.092	0.001

*Significance < 0.1; **Significance < 0.05; ***Significance < 0.01.

Table 4
Linear regression models on satisfaction of walking for leisure and recreation.

	Model 2a	Model 2b	Model 2c
	B (SE)	B (SE)	B (SE)
Constant	5.638 (0.096) ***	5.790 (0.199) ***	4.863 (0.206) ***
Socio-demographic variables			
Age			
18–30	−0.486 (0.095) **	−0.515 (0.105) **	−0.475 (0.113) **
31–40	−0.574 (0.128) **	−0.606 (0.057) ***	−0.585 (0.071) ***
41–50	−0.304 (0.120) *	−0.297 (0.094) *	−0.310 (0.097) **
51–60	−0.327 (0.121) *	−0.293 (0.087) **	−0.271 (0.084) **
Male	−0.128 (0.104)	−0.083 (0.095)	−0.093 (0.097)
Full-time employed	−0.229 (0.156)	−0.205 (0.143)	−0.175 (0.139)
Length of residency			
2–5 years	0.178 (0.175)	0.147 (0.151)	0.172 (0.136)
6–10 years	0.467 (0.158)*	0.361 (0.129)*	0.346 (0.126)*
>10 years	0.386 (0.110) **	0.177 (0.200)	0.156 (0.194)
Income			
100,001 to 300,000	0.115 (0.078)	0.087 (0.053)	0.075 (0.048)
Over 300,001	0.129 (0.044)*	0.010 (0.049)	0.008 (0.043)
BMI			
<18.5	0.006 (0.147)	0.010 (0.152)	0.065 (0.124)
18.5–24.9	0.130 (0.038) **	0.097 (0.031)**	0.121 (0.041)*
Neighbourhood characteristics			
Inner urban	0.188 (0.069)*	0.083 (0.106)	0.007 (0.131)
High accessibility	0.056 (0.094)	0.029 (0.156)	0.020 (0.155)
Built environment variables			
Access to destinations		0.131 (0.057)	0.097 (0.068)
Aesthetics		0.125 (0.043)*	0.076 (0.034)
Street network		0.129 (0.049)*	0.101 (0.044)
Physical infrastructure		−0.080 (0.098)	−0.094 (0.084)
Maintenance and upkeep		0.065 (0.097)	0.012 (0.084)
Traffic safety		−0.163 (0.043) **	−0.121 (0.043) *
Personal safety		−0.071 (0.039)	−0.076 (0.029) *
Poor footpath condition		−0.084 (0.052)	−0.063 (0.050)
Neighbourhood attachment			0.287 (0.086)**
Sample size	711	709	709
R^2	0.154	0.236	0.276
Changes in R^2		0.082	0.040

*Significance < 0.1; **Significance < 0.05; ***Significance < 0.01.

responsibilities walking, showing that respondents living in inner urban and high accessibility neighbourhoods are more satisfied with their walking trips. In the second model (3b), adding the environmental perception variables increased the R^2 to 0.185 (increase by 0.085). But in this model, the neighbourhood characteristics variables are no longer significant, rather, the built environment variable access to destinations is significant and has positive effects on walking satisfaction. In the third model (3c), adding neigbhourhood attachment increased the R^2 to 0.224 (increase by 0.039). First, it is observed that neighbourhood attachment has significant positive influence on walking satisfaction. For environmental perceptions, apart from access to destinations, street network is also found to be associated with walking satisfaction. However, unlike the models about walking satisfaction for leisure and recreation (Models 2a to 2c), the inclusion of neighbourhood attachment in this model (3c) did not result in reduction of the effects of environmental perceptions. For instance, access to destinations and street network are both significant and have positive effects on walking satisfaction even when neighbourhood attachment is also included in Model 3c.

Table 5
Linear regression models on satisfaction of walking for household responsibilities.

	Model 3a	Model 3b	Model 3c
	B (SE)	B (SE)	B (SE)
Constant	5.243 (0.097) ***	5.356 (0.175) ***	4.529 (0.238) ***
Socio-demographic variables			
Age			
18–30	−0.410 (0.035) ***	−0.411 (0.081) **	−0.377 (0.077) **
31–40	−0.464 (0.123) **	−0.467 (0.081) **	−0.448 (0.083) **
41–50	−0.181 (0.084)	−0.140 (0.027) **	−0.153 (0.012) ***
51–60	−0.313 (0.071) **	−0.240 (0.135)	−0.221 (0.146)
Male	−0.063 (0.038)	−0.046 (0.049)	−0.054 (0.050)
Full-time employed	−0.119 (0.139)	−0.096 (0.136)	−0.070 (0.134)
Length of residency			
2–5 years	−0.041 (0.125)	−0.049 (0.114)	−0.027 (0.099)
6–10 years	0.051 (0.099)	−0.040 (0.057)	−0.054 (0.048)
>10 years	0.253 (0.131)	0.065 (0.155)	0.047 (0.146)
Income			
100,001 to 300,000	0.098 (0.036)*	0.077 (0.057)	0.066 (0.067)
Over 300,001	0.278 (0.138)	0.174 (0.152)	0.172 (0.151)
BMI			
<18.5	0.128 (0.179)	0.129 (0.190)	0.178 (0.173)
18.5–24.9	0.178 (0.079)	0.151 (0.083)	0.172 (0.069)*
Neighbourhood characteristics			
Inner urban	0.116 (0.026)**	0.015 (0.019)	−0.053 (0.041)
High accessibility	0.133 (0.004) ***	0.101 (0.072)	0.093 (0.071)
Built environment variables			
Access to destinations		0.197 (0.028) ***	0.167 (0.039)**
Aesthetics		0.106 (0.036)*	0.062 (0.036)
Street network		0.114 (0.037)*	0.091 (0.023)**
Physical infrastructure		0.022 (0.137)	0.010 (0.126)
Maintenance and upkeep		−0.022 (0.064)	−0.070 (0.055)
Traffic safety		−0.073 (0.033)	−0.035 (0.035)
Personal safety		−0.085 (0.053)	−0.090 (0.050)
Poor footpath condition		−0.085 (0.037)	−0.066 (0.039)
Neighbourhood attachment			0.256 (0.065)**
Sample size	710	708	708
R^2	0.100	0.185	0.224
Changes in R^2		0.085	0.039

*Significance < 0.1; **Significance < 0.05; ***Significance < 0.01.

4.1.3. Life satisfaction

In this section, we further explore the effects of built environment and walking satisfaction on life satisfaction. First, socio-demographic variables and neighbourhood characteristics were entered in the model (4a), followed by adding environmental perceptions in the second model (4b), and finally, neighbourhood attachment and average walking satisfaction[7] were added into the third model (4c). The results are shown in Table 6. The R^2 of the first model is only 0.121, length of residency and income have positive effects on life satisfaction; while full-time employment has negative impacts to life satisfaction. For neighbourhood characteristics, living in inner urban and high accessibility neighbourhoods are both conducive to life satisfaction. Including environmental perceptions improved the R^2 of the model (Model 4b) by 0.134 (from 0.121 to 0.255), the aesthetic qualities of the environment

[7] We use average walking satisfaction instead of walking satisfaction for three specific purposes of walking to avoid the issue of multicollinearity.

Table 6
Linear regression models on life satisfaction.

	Model 4a	Model 4b	Model 4c
	B (SE)	B (SE)	B (SE)
Constant	21.776 (0.461) ***	22.719 (0.741) ***	13.53 (1.040) ***
Socio-demographic variables			
Age			
18–30	−0.322 (1.094)	0.002 (0.909)	0.677 (0.790)
31–40	−0.524 (0.780)	−0.310 (0.569)	0.320 (0.622)
41–50	0.069 (0.668)	0.491 (0.528)	0.651 (0.572)
51–60	−1.231 (1.048)	−0.382 (0.641)	−0.040 (0.553)
Male	−0.045 (0.460)	0.110 (0.327)	0.131 (0.254)
Full-time employed	−1.622 (0.343) **	−1.560 (0.299) **	−1.277 (0.320) **
Length of residency			
2–5 years	1.479 (0.352)**	1.392 (0.379)**	1.461 (0.409) **
6–10 years	2.354 (0.349) ***	1.851 (0.379)**	1.662 (0.404) **
>10 years	3.222 (0.713)**	1.717 (1.056)	1.525 (0.952)
Income			
100,001 to 300,000	0.939 (0.574)	0.845 (0.406)	0.724 (0.396)
Over 300,001	2.509 (0.637)**	1.596 (0.982)	1.504 (0.975)
BMI			
<18.5	−0.519 (0.626)	−0.633 (0.653)	−0.426 (0.553)
18.5–24.9	−0.714 (0.337)	−0.964 (0.315) *	−0.941 (0.263) **
Neighbourhood characteristics			
Inner urban	1.381 (0.212) ***	0.742 (0.112) ***	0.352 (0.125)*
High accessibility	1.521 (0.200) ***	0.625 (0.216)*	0.510 (0.182)*
Built environment variables			
Access to destinations		1.511 (0.586)*	1.213 (0.597)
Aesthetics		1.041 (0.161) ***	0.718 (0.099) ***
Street network		0.983 (0.190)**	0.775 (0.211) **
Physical infrastructure		0.231 (0.606)	0.166 (0.463)
Maintenance and upkeep		0.811 (0.298)*	0.525 (0.257)
Traffic safety		0.156 (0.234)	0.434 (0.237)
Personal safety		0.008 (0.461)	0.049 (0.426)
Poor footpath condition		−0.329 (0.155)	−0.120 (0.168)
Neighbourhood attachment and walking satisfaction			
Neighbourhood attachment			1.392 (0.117) ***
Average walking satisfaction			0.839 (0.261) **
Sample size	711	709	709
R^2	0.121	0.255	0.306
Changes in R^2		0.134	0.051

*Significance < 0.1; **Significance < 0.05; ***Significance < 0.01.

and street network were found to have positive effects on life satisfaction.

Assess to destinations and maintenance and upkeep were also positively associated with life satisfaction (although only significant at the 0.1 level), showing that favourable built environment features within the neighbourhood were also important for people's well-being. This finding is in line with previous literature that highlighted the importance of the physical environment and travel convenience in affecting residents' life satisfaction (Ma et al., 2018). In the third model (4c), inclusion of neighbourhood attachment and average walking satisfaction further improved the R^2 of the model by 0.051. These two variables have significant positive effects on life satisfaction. Showing that apart from how the participants perceive the built environment, their attachment to their neighbourhood also has positive influence on their life satisfaction. The positive associations of walking satisfaction to life satisfaction are also consistent with my expectations and previous literature (Waygood et al., 2019). Overall, among the eight environmental perceptions factors, only two of them (aesthetics and street network) were significant in the third model (4c), while neighbourhood attachment and walking satisfaction still have positive influences on people's life satisfaction when all socio-demographic and built environment factors have been controlled for in the model.

4.2. Qualitative findings

Three themes that emerged from participants' articulations help to explain the entangling relationships between their feelings towards neighbourhood, walking experience, and life satisfaction. This section elaborates each theme and in what ways their neighbourhood attachment shapes their walking and life satisfaction.

4.2.1. Emotional bonding with neighbourhood

Firstly, in several participants' narratives, they exhibited strong emotional bonding to neighbourhood which has powerfully affected their perceptions towards the neighbourhood environment, moderating their feelings during daily walking. For instance, Ms. Tam (female, 50, Xinzhou) has been living in her neighbourhood for 20 years. She exhibited a strong sense of belonging to her neighbourhood, expressing mixed feelings of pride, hope, expectations towards and a strong place dependence on her neighbourhood. Such emotional elements shaped how she perceived the walking environment and consequently led to a higher level of acceptance to the walking conditions, which were indeed chaotic most of the time. She said:

> "This is my neighbourhood; this is my home. I do exercise here, I shop here, I spend time with my family here…actually I can do anything I need without leaving this area. I know the construction works are annoying. They block the footpaths… make everything chaotic. But it will get better afterwards. There is a saying in Chinese: 'Today's trouble is for tomorrow's happiness' [今天的忍耐是為了明天的花開]. When the construction works are done, it'll be completely different. I am looking forward to it."

Tam's descriptions are typical in revealing the importance of affective elements in one's neighbourhood attachment in determining how people perceived the neighbourhood environment during walking. How she portrayed her neighbourhood was closely associated with its positive aspects, such as how her neighbourhood facilitated her daily activities, and her sense of pride and hope towards the future of her neighbourhood. She cared more about how the neighbourhood would be transformed to a better place to live, rather than its poor condition of the footpath due to the construction works.

4.2.2. Memories and meanings fostered in neighbourhood

Likewise, other participants also highlighted the cognitive aspects of their neighbourhood attachment in connecting their sense of place to walking and life satisfaction. Several participants mentioned that the memories they fostered with their family members during neighbourhood walking became a significant part of their life, making their neighbourhood walking a meaningful event for their life satisfaction and well-being. For example, Ms. Liang (female, 25, Huilongpu) has been living in her neighbourhood for eight years. Her home was located in a lively street occupied by small restaurants, shops, street vendors and BBQ stalls. Her articulated walking experience was all about the treasurable memories, intimacy, and fun moments she experienced with her mother, in spite of the crowded walking environment:

> "The best time of my day is walking with my mother after work. We have endless topics on our way back home. We talked about my career, my dreams, her day, her dreams; we gossip, and imagine our

future life… sometimes we have dinner in one of the BBQ stalls. I ask her to buy me snacks from the peddlers, and then we go shopping…I just get used to this. It is the major part of my life. If you ask my feelings about this neighbourhood or our walking trips, I think they are all about these memorable moments and happiness I have with my mum. They make this busy street unique and meaningful. Even though some days in the future we may move to another neighbourhood, I will always treasure our memories here."

Ms. Liang's story is a typical case that shows how walking experience can be affected by memorable moments with family and friends and their stronger sense of place. As Keightley (2010) argues, memories should not be regarded only as a process of making sense of the past, but also as an important extension to the present and future. This demonstrated that in some cases, memories and meanings created by the pedestrians during their trips could play a much more important role in shaping their satisfaction than the built environment features.

4.2.3. From familiarity to behavioural dimension of attachment

Several participants brought together other cognitive and behavioural aspects of their neighbourhood attachment, such as familiarity, knowledge of the neighbourhood and the desire to stay in their neighbourhood, in terms of how these elements led to a higher level of walking and life satisfaction. They regarded themselves as the expert of the neighbourhood, who had become well-informed about various perspectives of this neighbourhood after years of residence, including its people, events and any on-going or future changes. This allowed them to do all kinds of walking activities and fulfil their functional needs without leaving their neighbourhood. For example, Mr. Huang (male, 64, Xinsha) demonstrated that he was not willing to go outside of his neighbourhood, as he was able to conduct all kinds of activities in this area. He expressed this in the interview:

"I think nobody is more familiar [with this neighbourhood] than I am. I have been living here forever. I am an explorer. I enjoy walking and exploring my neighbourhood. These are my daily routines. [Starting to point at places on the map] There's a supermarket… this is a fresh food market… we also have a fish market there… not everyone knows these places. I can walk for about 10 minutes to reach all these places in one trip. That's why I don't need to leave this neighbourhood…everything is so convenient."

His case further explained how individuals' cognitive dimension of neighbourhood attachment was transformed to behavioural dimension of attachment, and together resulted in much higher evaluations of their own neighbourhood, walking trips and even life. This observation coincides with Lewicka's (2013) interpretations about why more attached residents are more interested in walking and exploring new destinations in their neighbourhood, and further demonstrated the process of how neighbourhood attachment affected pedestrians' feelings through rich knowledge, high evaluations of the neighbourhood, and habitual daily activities and walking behaviour, all of which in turn contributed to their life satisfaction (Scannell & Gifford, 2010).

5. Discussion

In this study, we analysed the effects of socio-demographics, perceived built environment and neighbourhood attachment on walking and life satisfaction for adults in Shenzhen, China. We found that neighbourhood attachment had positive effects on walking satisfaction for leisure/recreation and household responsibilities trips, and these effects were significant when socio-demographics and the built environment variables were controlled for in the models. Nonetheless, including neighbourhood attachment in the final model lowered the significance of other built environment variables for leisure/recreation walking satisfaction (Model 2c), but for household responsibilities walking satisfaction (Model 3c) the built environment variables remain significant. These findings suggest that the connections between environmental perceptions and neighbourhood attachment and pedestrians' satisfaction for walking trips are more complex than we commonly assumed. The qualitative findings further justified the rationale behind this finding. For instance, interviewees with stronger neighbourhood attachment were less sensible to their walking environment. In these cases, their sense of belonging, feelings of pride and expectations towards their neighbourhood moderated the influence of the build environment features on walking satisfaction and these factors were taken as more important in shaping their walking experience. In this respect, this study advances the current understanding of the associations between built environment, neighbourhood attachment and walking satisfaction by highlighting the relational power of place and place attachment in walking satisfaction (Chan et al., 2020; Li & Chan, 2018).

From the analyses, we also observed insignificant effects of neighbourhood attachment on walking for work/school. This finding echoes with Vilhelmson's (1999) study on time use and mobility in discussing how walking trips associated with work/school are usually less flexible in terms of time and space, as the location of office and when you need to arrive at the office is very likely to be the same. As a result, pedestrians' place-based bonding associated with their walking environment during these walking trips are much weaker, leading to the insignificant associations between neighbourhood attachment and walking satisfaction. On the contrary, walking for leisure/recreation and household responsibilities are more flexible and pedestrians are more likely to establish stronger bonding with their walking environment during these trips; and their attachment, in turn, will affect their perceptions of the walking environment and further influence their walking satisfaction. This result coincides with some thinking on the varying effects of the built environment on specific purposes of walking, that people are willing to assign different meanings or importance to their trips, and it would be prominent to take the trip purposes and meanings into consideration (Chan et al., 2019; Gao et al., 2020).

Regarding life satisfaction, we found that length of residency had positive effects on life satisfaction, but only for those who have been living in their neighbourhood for 2 to 10 years. This observation affirms the finding by Lu et al. (2018) that residents who have a higher level of neighbourhood attachment are usually more satisfied with their neighbourhood and life. Age and income had no effect on life satisfaction in our model, which contradicted with some previous studies that found people with higher income usually have higher life satisfaction (Sacks et al., 2012), or a U-shaped relationship between age and life satisfaction (Mroczek & Spiro, 2005). The insignificance of these socio-demographic variables might be attributed to the inclusion of the neighbourhood characteristics and built environment variables, which were commonly excluded in many previous studies (McCarthy & Habib, 2018). For instance, residents living in urban and other neighbourhoods with higher local accessibility have higher life satisfaction and this can be explained by the greater access to local destinations as discussed in other studies (De Vos et al., 2013; Ettema et al., 2010). In terms of built environment, aesthetics and street network both have positive influences on life satisfaction. This finding aligns with previous studies which have demonstrated that residents living in neighbourhoods with better aesthetic qualities have better mental health conditions and life satisfaction (Honold et al., 2016; McCarthy & Habib, 2018).

The qualitative findings have explained some of the plausible mechanisms through which neighbourhood attachment shape local residents' walking experience and life satisfaction. For instance, the qualitative findings exhibited the entwined processes of how pedestrians construct meanings, memories, and attachments to their neighbourhood during walking practice, and how these elements further shape their evaluations of walking trips and life. However, the relationships between neighbourhood attachment, walking satisfaction and life satisfaction might be bidirectional and even more complex than proposed. Here, we are by no means claiming that the results of this study represent the whole process of how neighbourhood attachment shapes

walking satisfaction and life satisfaction. Instead, this study provides one of the early attempts for understanding this process. Drawing upon the tripartite framework of place attachment (Scannell & Gifford, 2010) and the participants' own articulations, we call for more research in the future to further explore the role of people's affective responses, cognitive and behavioural level of place attachment and their effects on people's well-being especially in developing city context (Bornioli et al., 2019).

6. Concluding remarks

This study incorporated an important concept – neighbourhood attachment, to enrich the existing literature on the relationships between the built environment, walking and life satisfaction. Adopting a mixed-methods design, we found that neighbourhood attachment had significant positive effects on both individual's walking satisfaction and life satisfaction. In addition, the qualitative narratives further explained the ways through which neighbourhood attachment shaped pedestrians' walking and life satisfaction. Themes of affective and emotional bonds, cognitive and behavioural aspects of neighbourhood attachment were highlighted to have modified individual's perceptions on their neighbourhood environment, which further connected pedestrians' feelings, memories, and knowledge of the neighbourhood to their walking and life satisfaction.

The insights from this study provided important implications for land use and transport policies. Recognizing that individuals' responses to the environment are complex and idiosyncratic, researchers have called for more in-depth examination of the roles of contextual influences on person–place interactions (Kwan, 2018; Kwan & Schwanen, 2016). The results of this study demonstrated that neighbourhood attachment is one of the important personal characteristics in explaining why some people are more satisfied with their walking experiences and neighbourhoods. Nonetheless, there are many other personal characteristics (e.g. habit, attitudes, preferences) that may also play significant roles in shaping the links between the built environment, walking and life satisfaction. This paper suggests that transport and planning practitioners should not only focus on improving the built environment features in promoting walking, but also investigate the roles of other personal-related factors in shaping pedestrians' travel satisfaction and life satisfaction. One way to do so is to draw insights from the urban planning and design literature, in terms of how various place-making activities may encourage residents to explore and engage with the neighbourhood environment (Severcan, 2015). These “intangible” measures could be considered in practitioners' toolbox and complement with other “tangible” measures which were proved to be effective in developing a enjoyable walking environment.

This study also contributes to the detailed investigations of people's walking satisfaction of three specific purposes. We further found that various built environment factors have different effects on walking satisfaction for respective trip purposes. Such differences demonstrated the factors that shape people's walking satisfaction are highly relevant to the specific purposes of each trip, as pedestrians are very likely to unconsciously assign different importance to different aspects of the built environment during their walking trips. This will further affect how such built environment features influence their walking satisfaction. Further studies are needed to explore walking satisfaction for trips with different purposes, the activities performed, and emotions evoked during and after these trips (De Vos, 2019).

The limitations of this study should also be acknowledged. First, the findings were based on cross-sectional data which was not inferring causality about the relationships between neighbourhood attachment, walking satisfaction, and life satisfaction. Although the qualitative narratives provided explanations on the proposed connections, more in-depth qualitative studies are required to further address the complex relationships between pedestrians' personal characteristics, the built environment, and walking and life satisfaction. In fact, the combination of longitudinal data and experimental design could be used in the future to better capture the changing relationships between residents' neighbourhood attachment, walking behaviour, satisfaction and well-being. In addition, other statistical methods, such as structural equation modelling, can be used to explore the complex relationships between the variables of concern, identify both direct and indirect effects through various mediating variables and compare multiple models to test different hypotheses about the direction of relationships. Second, this study applied measurement items developed and tested in existing literature to assess people's neighbourhood attachment, walking satisfaction and life satisfaction, which might only partially capture the socio-cultural specificities of Chinese pedestrians' interpretations of walking and life satisfaction. The future studies could go beyond these measures that were originated from western cases and use explorative methods to extract measures with Chinese cases to address the idiosyncratic nature of pedestrians' different perceptions associated with the built environment, place attachment, walking and life satisfaction.

CRediT authorship contribution statement

Eric T.H. Chan: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. **Tingting Elle Li:** Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing.

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

Data will be made available on request.

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Appendix. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cities.2022.103940.

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