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Original article

Urban-greenway factors' influence on older adults' psychological well-being: A case study of Taichung, Taiwan

Po-Ju Chang[a,*], Chun-Wei Tsou[b], Yi-Shan Li[c]

[a] Department of Horticulture and Landscape Architecture, National Taiwan University, Taiwan
[b] Department of Landscape Architecture, Tunghai University, Taichung, Taiwan
[c] Construction Bureau of Taichung City Government, Taichung, Taiwan

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ABSTRACT

In Taiwan, about 80 % of the population lives in urban areas, and as the number of older adults inches toward 20 % of the total population by 2026, Taiwan is expected to become a super-aged society. Because urban green spaces are critical for maintaining older adults' physio-psychological health, maintenance of these spaces can assist the aging-in-place process. Urban greenways not only provide physical environments that support leisure activities, but also create a social environment in which older adults can develop place attachment. These areas improve older adults' psychological well-being. By contrast, urban environmental stressors (e.g., noise and air pollution) may affect older residents' well-being negatively. Therefore, this study developed a structural equation model to examine the relationship between physical environment and well-being from urban greenways in Taichung, and it examined how local older residents' place attachment and perceived environmental stressors influence this relationship. Our dataset included 13 greenways and 769 participants older than 55 living in the vicinity of these greenways. The results indicate that participants perceive lower levels of environmental stress when their local greenway quality is better, enhancing levels of well-being and place attachment, as reported by older adult residents. Since urban greenways are linear public spaces adjacent to roads, greenway designers and planners should place more emphasis on environmental quality to help create high-quality and easy-to-maintain public spaces where older adults can enjoy the outdoors and improve their well-being without worrying about environmental stressors.

1. Introduction

More than half the world's population lived in urban areas in 2018, and that level is expected to reach over 70 % by 2050 (World Health Organization (WHO, 2013). In Taiwan, 78.2 % of the population lives in urban areas (Directorate General of Budget, Accounting, and Statistics, 2018). As rapid urbanization development reduces the amount of green spaces, chances for urban residents to connect with nature have decreased. In addition to urbanization, Taiwan is expected to become a super-aged society by 2026, which means that over 20 % of the population will be older than 65 (Directorate General of Budget, Accounting, and Statistics, 2014). Maintaining and extending older adults' life expectancy is crucial, and urban green spaces provide older residents with easy access to nature. One such type of space is called urban greenways (Akpinar, 2016a), which are defined as road-based, linear, open spaces of various widths that provide recreational spaces (Fabos, 1995; Little, 1995). Greenways can improve urban microclimatology, compensate for the lack of green spaces in developed urban areas, and provide urban residents with venues for stress reduction and recreational activities, thereby strengthening their emotional bond to the place (Akpinar, 2014, 2016a). Although previous studies have demonstrated the benefits of urban green spaces, most have focused on users of urban parks, with less attention paid to urban greenways and older residents who live near them (Hou, Kuo, & Tseng, 2011).

Parks near older adults' homes are the most popular spaces for leisure activities in Taichung, Taiwan, and the most important factors that these residents cite concerning park satisfaction are location, design, and maintenance (Hou, Kuo, & Tseng, 2011). Despite greenways being urban green spaces near older adults' homes, they often are located between roads, exposing users to traffic noise and air pollution, resulting in negative health outcomes (Winkel et al., 2009). Although

* Corresponding author at: Department of Horticulture and Landscape Architecture, National Taiwan University, Taipei, No. 138, Section 4, Keelung Rd, Da'an District, Taipei City, 106, Taiwan.
E-mail addresses: pojuchang@ntu.edu.tw (P.-J. Chang), cwtsou@thu.edu.tw (C.-W. Tsou), iris7154@taichung.gov.tw (Y.-S. Li).

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previous studies have demonstrated environmental stressors' risks to health, few have discussed environmental stressors' negative effects on users of urban spaces, especially older residents. Moulay et al. (2018) concluded that while most studies aid urban designers in improving urban public spaces' function and quality, fewer studies have focused on the process of place attachment, which influences people's emotions, meanings, and behaviors.

Furthermore, Lewicka (2011) reviewed place-attachment studies spanning 40 years and found that previous studies paid too little attention to places' physical nature. Therefore, this study investigated Taiwan's greenway system to examine the greenway environment's effects on older adults' well-being. To achieve the goals of aging in place and successful aging in general, this study sought to determine (1) greenways' environmental stressors (e.g., noise, trash, and air pollution), as perceived by residents, and (2) the influence of residents' place attachment on their well-being. This study's results can provide research and practical contributions to current problems tied to urbanization and aging societies.

2. Theoretical background and hypotheses

2.1. Environment and well-being

Urban green spaces offer stress recovery by relieving urban residents' pressures from living and working in high-density urban environments, as well as restoring balance in their lives (Nath et al., 2018). Among all types of urban green spaces, extant studies have emphasized greenways' importance the most, indicating that they provide residents with safe spaces for recreation and exercise, thereby furthering community health (Liu et al., 2018a, 2018b). Greenways can be any open green space near a residence that provides the following functions: (1) easing life's pressures; (2) allowing for self-health evaluation; (3) reducing anxiety and depression; and (4) increasing life expectancy (Maas et al., 2006; van den Berg et al., 2010; Wells and Evans, 2003). The main reasons for urban residents to use greenways include maintaining their health and overall physical fitness, embracing outdoor recreation, and connecting with nature (Lindsey, 1999; Akpinar, 2016b). The main factors that affect greenway usage are scenic beauty, degree of naturalness, vegetation, bodies of water, trail surfaces, maintenance, individual safety, distance from cars and traffic, peace-and-quiet atmosphere, and proximity to home (Gobster, 1995). In addition, trail paths, rest benches, barbecue areas, restrooms, and other service facilities can increase an urban green space's attractiveness, thereby increasing the time that users spend there (Van Herzele and Wiedemann, 2003). Older adults often sit on benches or shade trees when they take walks (Rodiek and Fried, 2005). Jong et al. (2012) revealed that perceived green quality exhibited a stronger relationship with subjective well-being indicators than with an objective greening index value (e.g., one derived from a geological information system). This result indicates that although an objective measuring tool could evaluate the degree of greening, it was unable to account for interactions between an individual and a green space. Therefore, based on previous findings, this study proposed the following hypothesis:

H1. Greenway quality is related positively to individual well-being.

2.2. Environmental stressors

Urban green spaces' ability to provide neighboring residents with sufficient fitness equipment and exercise opportunities is limited by factors such as facility quality and environmental pollution (Xing and Brimblecombe, 2018; Yli-Pelkonen et al., 2017). Park size and total tree-canopy cover significantly removed air pollution and reduced noise levels, regardless of the park's location and tree species (González-Oreja et al., 2010; Margaritis and Kang, 2017; Nowak et al., 2006). However, because greenways are linear and usually situated adjacent to traffic lanes, thin belts of vegetation cannot fully block air pollution and road noise from traffic. Long-term contact with stressors has been found to cause health risks, including emotional difficulties, social withdrawal, insomnia, and high blood pressure (Adler and Hillhouse, 1996; Marsland et al., 2001). The World Health Organization (WHO, 2013) has investigated various negative environmental factors—such as noise, air quality, and water pollution—to determine which environmental stressors caused diseases. While extant studies mainly have focused on single stressors' influence on health, multiple stressors may exist together or originate from the same source in urban environments. For example, urban traffic produces traffic-related noise, unpleasant odors, and polluted air simultaneously. Therefore, multiple stressors should be considered together when discussing urban environmental stressors (Honold, Beyer, Lakes, & Meer, 2002). Residents living on blocks with more environmental stressors exhibited more behaviors that are risky to their health (e.g., higher smoking and drinking frequency, and lower physical activity levels). Older adults' perceptions of their physical environments played a key role in their health and their relationship with the neighborhood because they are more sensitive to environmental stressors (O'Campo et al., 2015; Wen et al., 2006). Physical-environment factors—such as air quality, noise, living conditions, and open spaces—are all related to older adults' health conditions (Blafour and Kaplan, 2002; Wright and Fisher, 2003). Based on extant literature, this study proposed the following hypotheses:

H2. Greenway quality is related negatively to environmental stressors.

H3. Environmental stressors are related negatively to individual well-being.

2.3. Place attachment's mediating role

Whereas the neighborhood environment's objective conditions and individuals' cognitive functions are crucial, subjective emotions toward the neighborhood are key to increasing individual satisfaction (La Gory et al., 1985). The concept of aging in place represents the amount of security, familiarity, connection, and reliability that older adults perceive concerning their homes and communities, helping them gain self-identity through place attachment and independence. Long-term emotional attachment toward an environment can improve older adults' well-being (Rubinstein, 1990; Taylor, 2001). Place attachment represents an individual's relationship, emotions, and purpose toward an environment. The developmental theory of place attachment (Morgan, 2010) is defined as a developmental process that moves from unconscious interactions with a place to conscious attachment to this place. Moulay et al. (2018), quoting Lewicka (2011), noted that "in broader social and physical environments, such as neighborhoods, person-place bonding may comfort the inhabitants by affecting their cognitions and behaviors" (p. 29). Urban green spaces encourage residents to conduct outdoor activities and increase social interactions, thereby furthering community consciousness and support, as well as preventing loneliness. This improves individuals' well-being (Dinnie et al., 2013; Nath et al., 2018). Lewicka (2011) summarized all place-attachment predictors from recent studies and indicated that physical predictors, such as ratings of precinct cleanliness and vegetation, are place-attachment predictors.

The concept of place attachment usually involves two main dimensions: emotional and functional (Williams, Patterson, Roggenbuck, & Watson, 1992). The emotional dimension is viewed as "place identity," which is related to individuals' self-identity and refers to an individual establishing perceptions toward the environment, as well as an emotional attachment through behaviors, attitudes, values, and beliefs (Proshansky et al., 1983). Tsai (2012) indicated that place identity can be viewed as a situation in which an individual feels emotions that resemble those that the individual feels when at home. The author later suggested that it is critical to investigate place identity to understand

humans' connection to their environments (Tsai, 2016). The functional dimension is termed *place dependence,* which refers to whether the environment can satisfy each resident's crucial needs (e.g., experience or activity needs) (Moore and Graefe, 1994). Functional attachment is related more to a place's physical quality and often results in frequent visits (Williams and Vaske, 2003). While researchers have used the two-dimensional constructs of place attachment in many fields (Moore and Graefe, 1994; Williams and Vaske, 2003), researchers more recently have argued that measurements of sociocultural influence in this model are lacking. Kyle et al. (2004, 2005) added social bonding as a third dimension of place attachment to examine whether respondents' social investments in their neighborhoods affected their attachment to these neighborhoods. Luo et al. (2016) also indicated that two-dimensional place attachment fails to measure the social dimension of place attachment and added "social bonding" as the third dimension in their study in China to measure social connections to a place. They defined *social bonding* as "the feelings of belonging or membership to a group of people, as well as the emotional connections based on shared history, interests, or concerns" (p. 107).

Moulay et al. (2018) provided a broader theoretical proposition for public-place responsiveness after reviewing recent studies (e.g., Manzo & Devine-Wright, 2014; Lewicka, 2011; Devine-Wright, 2011; Fornara, Bonaiuto, & Bonnes, 2010; Raymond et al., 2010; Scannell & Gifford, 2010; Scopelliti & Tiberio, 2010). In their proposed model, physical effect is one of the public-place utilization dimensions that influence place attachment. The physical-effect factors include accessibility, proximity, aesthetics, and maintenance, among others. Numerous studies on urban green spaces have emphasized older adults' access to open spaces. Providing older adults with safe recreational facilities in open spaces increases their physical activity and social engagement, thereby further increasing well-being (Subramanian and Jana, 2018). However, environmental stressors may influence older adults who are attached functionally and emotionally to greenways. The development of place attachment includes an individual's perceived experience with the environment. Aspects of the urban environment (e.g., traffic and noise) may change the individual's perceived experience with the locale (Seamon, 2013). Thus, environmental stressors such as noise, air pollution, and littering may weaken older adult residents' place attachments. In a study on neighborhood sentiment, Lewicka (2011) indicated that pollution could be one of the physical predictors of place attachment. Based on the above statements, this study proposed the following hypotheses:

H4. Greenway quality is related positively to place attachment.

H5. Environmental stressors are related negatively to place attachment.

Individuals with high place attachment exhibit more positive emotions and adaptability (Low and Altman, 1992). Older adults' place attachment is strengthened across the aging process (Coulthard et al., 2002). To older adults, place attachment is related to life experience and self-identity, possibly because it represents part of their memories (Rubinstein and Parmalee, 1992). Therefore, place attachment is assumed to help older adults maintain self-identity and well-being, further helping them cope with the aging process (Wiles et al., 2011). However, individuals with higher levels of place attachment also exhibited greater sensitivity toward the environment and, thus, are affected more easily (Lawton, 1977). Because environmental stressors in urban lifestyles differ from those in rural lifestyles, the number of researchers focusing on urban residents as study targets is increasing (Oktay et al., 2009). Azevedo et al. (2013) revealed that urban residents with higher levels of place attachment were happier than those without them. However, if the green space familiar to a neighborhood were removed, its residents would experience adverse effects, such as increased obesity risks and an inability to relieve stress effectively (Lachowycz and Jones, 2013). Therefore, this study proposed the following hypothesis:

H6. Place attachment is related positively to individual well-being.

Place attachment has been viewed as a mediator in various research models, such as in the relationship between urban green spaces and health (Zhang et al., 2015). By providing a space to exercise, socialize, and create community consciousness, urban green spaces are crucial to the urban environment (Liu et al., 2018a, 2018b). Frequency of visits, proximity to residences, and landscape features were related positively to residents' place attachment in Malaysian urban public parks (Ujang et al., 2015). This suggests that place attachment can serve as an indicator of well-being. Zhang et al. (2015) used place attachment as a mediating factor to examine urban neighborhood green spaces with different features. The results revealed that frequent visits and higher-quality neighborhood green spaces allowed individuals to reap greater psychological health benefits from place attachment. Individuals' period of residence, education level, and financial status were found not to be related to the results. Moulay et al. (2018) referenced relevant studies and established their theoretical framework in relation to increasing residents' use of urban neighborhood green spaces. The framework assumes that an urban open space's physical conditions (e.g., aesthetics, maintenance, and distance) influence residents' behavioral intentions of using the open space through place attachment and user motivations.

Although numerous studies have emphasized how urban open green spaces serve as environmental assets and provide regional neighborhoods with benefits, environmental stressors' influence on urban residents' physio-psychological health also must be considered. Environmental stressors may reduce greenways' place attachment and benefits. If the urban outdoor environment does not comprise sufficient natural elements, residents exercising outdoors may be exposed to air pollution and traffic-related noise (Zijlema et al., 2017). Therefore, residents who exercise on greenways might experience environmental stressors because they are adjacent to roads, thereby lowering perceived greenway benefits such as increased well-being. Based on extant literature, this study proposed the following hypothesis:

H7. Place attachment mediates the relationship between environmental stressors and well-being.

3. Methods

This study employed two data-collection methods. To measure greenways' environmental quality, trained experts conducted an on-site evaluation using a revised version of the Environment Assessment of Public Recreation Scale (EAPRS). To evaluate older adults' experiences, questionnaires were distributed at the research location.

3.1. Study area

This study collected data on greenways in Taichung, Taiwan. Taichung is the only municipality in central Taiwan; the city center is located at 24.1477 °N, 120.6736 °E (Fig. 1), which is the Taichung Metropolitan Area's core city. Taichung's total area is 2215 km^2. As the second-largest metropolitan area in Taiwan, Taichung's population totaled 4.05 million in 2017 (World Population Census, 2015). Taichung is situated mainly in a subtropical monsoon climate. During summers (June to September), temperatures range between 26 and 33 °C. During winters (December to February), temperatures range between 13 and 21 °C. Average annual rainfall is 1773 mm, average total number of rainy days annually is 121, and average annual relative humidity is 75.6 % (Taichung Government, 2018). The Taichung Urban Greenway (TUG) system is the most developed greenway system in Taiwan. The earliest urban planning of greenways in Taichung can be dated back to the Japanese colonial period, but the TUG, including construction of its individual greenways, was not completed until 1996. Taichung has a total of 13 greenways ranging in size from 5,000–98,000 m^2. In this

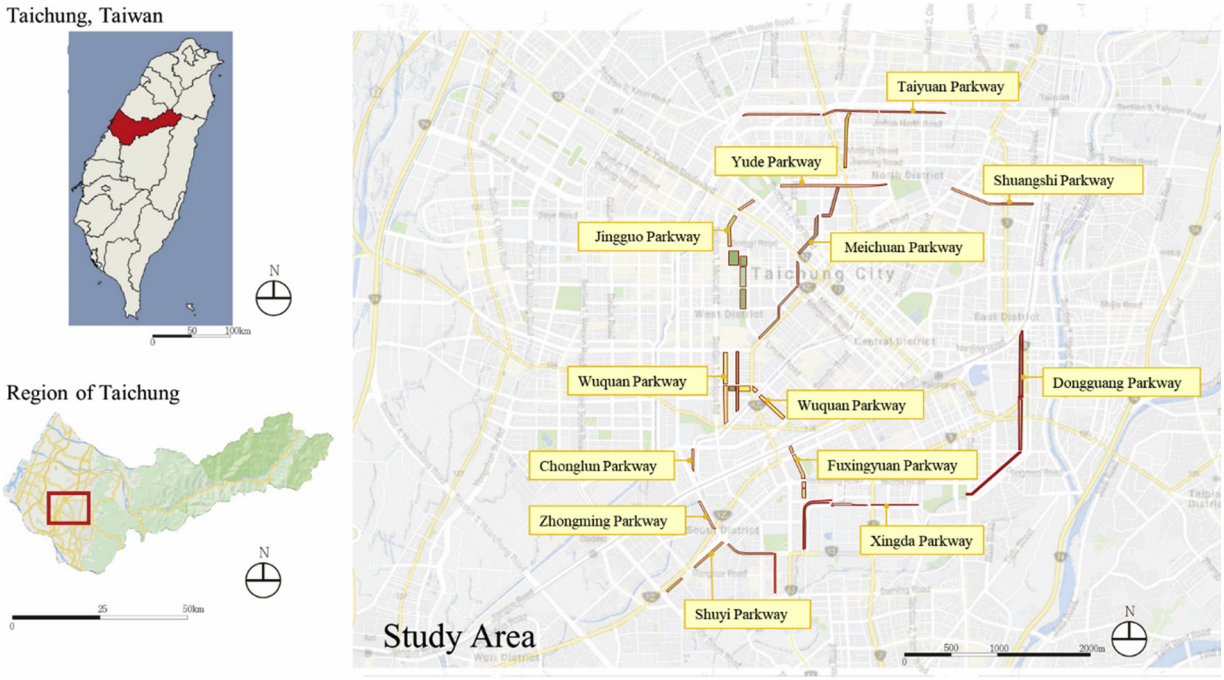

Fig. 1. Case study area*.
*Note: The base maps were retrieved from Google Maps.

study, all 13 greenways were included in data collection (Table 1).

3.2. Data collection: quality of urban greenway assessment

Greenway quality was evaluated through EAPRS, developed by Saelens et al. (2006). EAPRS evaluates a recreational space's facility availability and maintenance quality based on usage condition, which comprises 17 main qualities observed on-site by trained professionals. Because this study mainly focused on greenways, unrelated evaluation items from the EAPRS (e.g., beaches and swimming pools) were omitted, leaving only seven main items: facilities, seating; condition; landscaping; water; cleanliness; and coverage. The scale also referenced Saelens et al.'s (2006) settings: For the main items that indicated whether the greenway exhibited a feature (e.g., facility, seating, landscaping, and water), 1 = no and 2 = yes. The item scores were added to produce the main items' scores. Other main items were evaluated using their total average: The scores related to condition were graded as follows: 1 = poor; 2 = fair; and 3 = excellent. Scores related to cleanliness were graded as follows: 1 = not at all; 2 = somewhat; and 3 = mostly to extremely. Scores related to coverage were graded as follows: 1 = 0 %–33 %; 2 = 34 %–66 %; and 3 = 67 %–100 %. Table 2 provides further details.

3.3. Data collection: questionnaire on older adults' experiences

This study used convenience and snowball sampling methods. A small sample unit was used to obtain more information about the target sample unit. It is easy to find respondents in a targeted population, but the limitation is that a certain connection must exist between the sample unit and the willingness to provide and maintain this connection. This method is applicable when looking for people who are rare in the overall population. In investigating relevant research among the elderly, researchers often use snowball sampling to collect older samples (Vaportzis et al., 2017; Wilson and Spink, 2006). Furthermore, the average retirement age in Taiwan is 58.6 (Ministry of Labor, Taiwan, 2018). The Ministry of the Interior's Elderly Condition Survey is aimed at those over age 50 living in Taiwan. In addition, according to a series of studies on advanced age and employment policies, national reports from 21 countries defined senior citizens as those between ages 50 and 64 (Chou, 2006; Chou & Tsai, 2006). For this study's purposes, questionnaires were distributed to older adults over age 55 doing activities on greenways. Each questionnaire required approximately 15 min to complete, and at least 30 questionnaires were collected from each greenway.

The pilot questionnaires were distributed in January 2018, with a total of 89 samples collected, for a 100 % return rate. Altogether, 76 were deemed valid, for a valid response rate of 85.4 %, with 13 deemed invalid because these participants' ages did not meet the requirement, resulting in an invalid response rate of 14.6 %. The reliability test indicated that the questionnaire was reliable, with a Cronbach's alpha = 0.793. All items were included in the final questionnaire, which was administered from March to May 2018 (average temperature: 27.3 °C; average humidity: 77 %). Altogether, 840 questionnaires were obtained, for a return rate of 100 %, with 769 deemed valid (91.5 %) and 71 deemed invalid (8.5 %) because of incompleteness or because participants' ages did not meet the requirement. The aging population (age 65 and above) totals about 280,000 in Taichung. With a 95 % confidence interval, the sample size needed to yield results that precisely reflect the target population is 599. Therefore, the sample size in this study was appropriate. The greenway neighborhood range was set to be within a 500-mile radius of the neighborhood green space, according to neighborhood parks' service radius standards. After we drew the boundary on the map, participants were asked to mark their homes on the map to calculate the distance to the greenway. This study obtained Institutional Review Board approval under an expedited review (CRREC-106-061).

The questionnaire included four sections: environmental stressors; place attachment; well-being; and demographic information. The environmental-stressor section referenced four environmental stressors—air pollution, trash, behavior-related noise, and traffic-related noise—that were proven to influence individual emotional reactions in extant literature (e.g., Lazarus, 1990; Honold et al., 2012). This measurement exhibited high internal consistency in a previous study (Cronbach's $\alpha = 0.92$; Van Dyck et al., 2011). The place-attachment section comprised 12 items developed by Ryan (2005), covering three aspects: place dependence; place identity; and social bonding. The

Table 1
Results of Greenway physical environment assessment.

Category	Item	Range	Mean/Sum (S.D.)
Facility	1 Paved trail	48–96	53.47 (2.08)
	2 Trail Signage		
	3 Paved path to trail		
	4 Open restrooms on trail		
	5 Animal waste cleanup on trail		
	6 Trash can on trail		
	7 Fitness stations on trail		
	8 Path		
	9 Paved path		
	10 Open space		
	11 Drinking fountains		
	12 Picnic area		
	13 Vending		
	14 Restroom		
	15 Shelter/pavilion/ gazebo		
	16 Lighting on trail		
	17 Lighting on entrance		
Water	1 Water element on trail	4–7	5.12(.99)
	2 Water area		
	3 Fountain		
Seat or rest facility	1 Sit/rest place on trail	4–7	4.96 (.18)
	2 Seat wall		
	3 bleachers		
Condition	1 trail condition	1 = poor	2.17(.40)
	2 seat condition next to trail	2 = fair	(Cronbach's
		3 = excellent	Alpha = 0.725)
	3 path condition		
	4 seating area condition		
	5 landscaping condition		
	6 Area/neighborhood immediately surrounding park condition		
	7 Sidewalk condition		
Landscape	1 Landscaping next to trail	8–11	9.42 (.90)
	2 Meadow		
	3 Wooded area		
	4 Flowers		
	5 Shrubs/bushes		
	6 Landscaping beds		
Cleanliness	1 trail	1 = Not at all	2.15 (.35)
	2 trail clear from obstruction	2 = somewhat	(Cronbach's
	3 trail flatness	3 = mostly to extremely	Alpha = 0.784)
	4 path clear from obstruction		
	5 siting area cleanliness		
	6 cleanliness of viewing area		
	7 Area/neighborhood immediately surrounding park cleanliness		
	8 Entrance cleanliness		
	9 Sidewalks cleanliness		
	10 Terrace handrail		
Coverage	1 Trail coverage/shade	1 = 0–33 %	2.25(.48)
	2 Place to sit on trails under coverage/shade	2 = 34–66 %	(Cronbach's
		3 = 67–100 %	Alpha = 0.761)
	3 Path coverage/shade		
	4 Siting area coverage/ shade		

environmental stressors and place-attachment measurements were used on a five-point Likert scale to evaluate each participant's perception levels concerning greenway stressors (i.e., from highly influenced/disturbed/threatened to barely influenced/disturbed/threatened) and agreement (i.e., from strongly agree to strongly disagree). The items' mean scores served as indicators of environmental stressor and place attachment. Higher scores indicated that the individual exhibited higher place attachment. The scores for environmental stressors were reversed, i.e., a higher score indicated lower levels of perceived environmental stressors. The well-being section used Seligman's (2011) PERMA model, which comprises five aspects of well-being: positive emotion; engagement; positive relationships; meaning; and accomplishment. This questionnaire comprised 15 items, with three for each aspect, and used an 11-point Likert scale to evaluate individuals' condition (i.e., from every time to never). The items' mean score served as an indicator of well-being, with higher scores indicating that the individual experienced greater well-being. The demographic-information section recorded participants' gender, age, marital status, education level, and self-perceived financial status.

Table 2
Demographic information of study sample.

Variables		Frequency	(%)
Gender	Male	308	40.1
	Female	461	59.9
Age	55–60	222	28.9
	61–65	157	20.4
	66–70	146	19.0
	71–75	92	12.0
	76–80	73	9.5
	80 and above	79	10.3
Marital status	Unmarried/separated/ divorced	93	12.1
	Married	599	77.9
	Widowed	77	10.0
Education	Elementary school or below	193	25.1
	Junior high school	125	16.3
	High school	218	28.3
	College	199	25.9
	Master degree or above	33	4.3
Self-reported financial status	No income/ poor	61	7.9
	Average	352	45.8
	Fairly well-off or rich	356	46.3

3.4. Data analysis

Confirmatory factor analysis (CFA) and structural equation modeling (SEM) were performed to examine the hypotheses. Based on the factors and latent variables within the proposed hypotheses, CFA assessed the correlation between two variables to determine whether they were related. Following Fornell and Larcker's (1981), suggestion, composite reliability (CR) and average variance extracted (AVE) were selected as indicators. The CR value represents the construct indicators' internal consistency, suggested to be greater than 0.6. The AVE value represents latent variables' explanatory power of the measured variables. Hair et al. (2006) indicated that the AVE value should be greater than 0.25. After the CFA results were obtained, SEM was used to test each hypothesis. This study's goodness-of-fit values referenced Kline (2005): root mean square error of approximation (RMSEA); comparative fit index (CFI); parsimonious CFI (PCFI); normed fit index (NFI); Tucker-Lewis index (TLI); and normed chi-square ratio (χ^2/df). For RMSEA not to be influenced by sample size and model complexity, it must be smaller than 0.08. PCFI explains the model's simplicity, so it must be greater than 0.05. CFI and NFI demonstrate fitness between the model and null hypothesis, with required values greater than 0.095 and 0.09, respectively. For the normed chi-square not to be influenced by model complexity, it must fall between 1 and 3. Finally, the bootstrapping method was used to evaluate possible mediating effects from place attachment that existed in the relationship between environmental stressors and well-being. Regardless of which path was used in the bootstrapping process, if zero was not situated between the lower

and upper bounds, the indirect effect was not zero with *ci*% confidence (Hayes, 2009). SPSS Version 20 and AMOS (IBM, 2011) were used for statistical analyses.

4. Results

4.1. Demographics

Table 2 displays study participants' demographic information. The participants' mean age was 67.4, with more female participants (59.9 %) than males. Altogether, 77.9 % of the participants were married. Participants perceived their financial status as being middle class (45.8 %) or upper class (46.3 %). Most participants were educated to a high school diplomas (28.3 %), followed by college and junior high school diplomas (25.9 %). According to Taichung's 2017 demographic statistics, most residents over age 15 are at a high school education level (n = 489,696), followed by college education level (n = 485,342). Therefore, the study participants' education levels resembled Taichung's demographic statistical profile. Additionally, men comprise 46 % of the population over age 65 in Taichung, similar to this study's sample.

4.2. Hypothesis model

Table 3 presents obtained information from TUG users, including questionnaire items, reliabilities, and mean and standard-deviation values. Before the hypothesis model was verified, CFA was used to determine the relationship between factors in the hypotheses and related latent variables. As shown in Table 4, this model's CFA fulfilled the standards; therefore, SEM was used to conduct further verification. The null model's goodness-of-fit results in this study were as follows: RMSEA = 0.054; PCFI = 0. 800; CFI = 0. 924; TLI = 0.912; NFI = 0. 894; and $\chi 2/df = 2.243$. All goodness-of-fit results were within standard value ranges, indicating that this study's theoretical model can be used to analyze observation data thoroughly through SEM to verify the hypotheses.

Table 4
Confirmatory factor analysis.

Factors	Number of questions	Composite Reliability	Average Variance Extracted
Environmental Stressors	4	.843	.576
Greenway Quality	61	.885	.607
Place Attachment	12	.683	.429
Well-being	15	.731	.331

Fig. 2 displays the SEM results. Environmental stressors exerted a significantly positive influence on place attachment ($\beta = 0.102$, $p < 0.05$) and well-being ($\beta = 0.176$, $p < 0.001$). Greenway quality exerted a significantly positive influence on environmental disturbance ($\beta = 0.102$, $p < 0.001$) and an insignificant influence on place attachment. Place attachment exerted a positive influence on well-being ($\beta = 0.102$, $p < 0.001$). Furthermore, greenway quality did not exert significant influences on place attachment or well-being. Therefore, H2, H3, H5, and H6 were valid, and H1 and H4 were invalid. Among the factors related to greenway quality, condition ($\beta = 0.94$, $p < 0.001$) and cleanliness ($\beta = 0.85$, $p < 0.001$) were the most influential, whereas seating was the least influential ($\beta = 0.13$, $p < 0.001$). Among all factors, behavior-related noise ($\beta = 0.85$, $p < 0.001$) was the most influential environmental-stressor dimension, place identity ($\beta = 0.80$, $p < 0.001$) was the most influential place-attachment dimension, and positive emotions ($\beta = 0.86$, $p < 0.001$) were the most influential well-being dimension. After the model was established, this study used

Table 3
Items, reliabilities, and mean and standard deviation.

Scale items	Contexts	Means(SD)
Environmental stressors (Reversed)		($\alpha = .849$)
Behavior noise	Noise generated by human activities in the greenway, such as playing, chatting.	3.078 (1.586)
Traffic noise	Hear the sound of the car horn in the greenway.	2.676 (1.546)
Trash	See trash in the greenway.	2.562 (1.489)
Air pollution	Perceive automobile emission or smog in the greenway.	2.267 (1.427)
Place attachment		($\alpha = .693$)
Place identity	1. I feel very satisfied with this greenway.	4.161 (.727)
	2. I can do the recreation activities I want in this greenway.	4.038 (.799)
	3. If I move to another place, I will miss it here.	4.130 (.836)
	4. The existence of this greenway makes me very happy.	4.308 (.663)
	5. I like the greenway and the plants here, it makes me feel familiar.	4.109 (.836)
	6. I like to tell people that I live very close to this greenway.	4.043 (.931)
Social bonding	1. I have a good memory about this greenway.	3.934 (.887)
	2. I am in contact with this greenway because of different events.	3.841 (.890)
	3. I have a special connection with people who come here.	3.693 (1.034)
Place dependence	1. It is boring to come here too often.	1.943 (.935)
	2. I feel that I am not too deeply connected to this greenway.	2.484 (1.133)
	3. I will bring my child or grandson here.	3.670 (1.316)
Well-being		($\alpha = .939$)
Positive emotion	1. I feel happy in general.	9.026 (1.923)
	2. I am positive in general.	9.125 (1.874)
	3. I feel satisfied in general.	9.092 (1.909)
Engagement	1. I focus on what I am doing.	8.891 (2.116)
	2. I am excited and interesting about something in general.	8.726 (2.140)
	3. When I was doing something pleasant, I forgot the passage of time.	9.053 (2.104)
Meaning	1. I am heading towards a purposeful and meaningful life in general.	8.916 (2.112)
	2. My life is worth it in general.	9.095 (1.944)
	3. I know where the direction of life is.	8.753 (2.355)
Positive relationship	1. Get help or support from others when I need it.	8.610 (2.427)
	2. I feel loved.	8.696 (2.242)
	3. I am content with my personal relationship.	8.856 (2.062)
Achievement	1. I am reaching my goal.	8.356 (2.650)
	2. I have reached a major goal set for myself.	8.225 (2.568)
	3. I can take responsibility for myself.	9.489 (1.817)

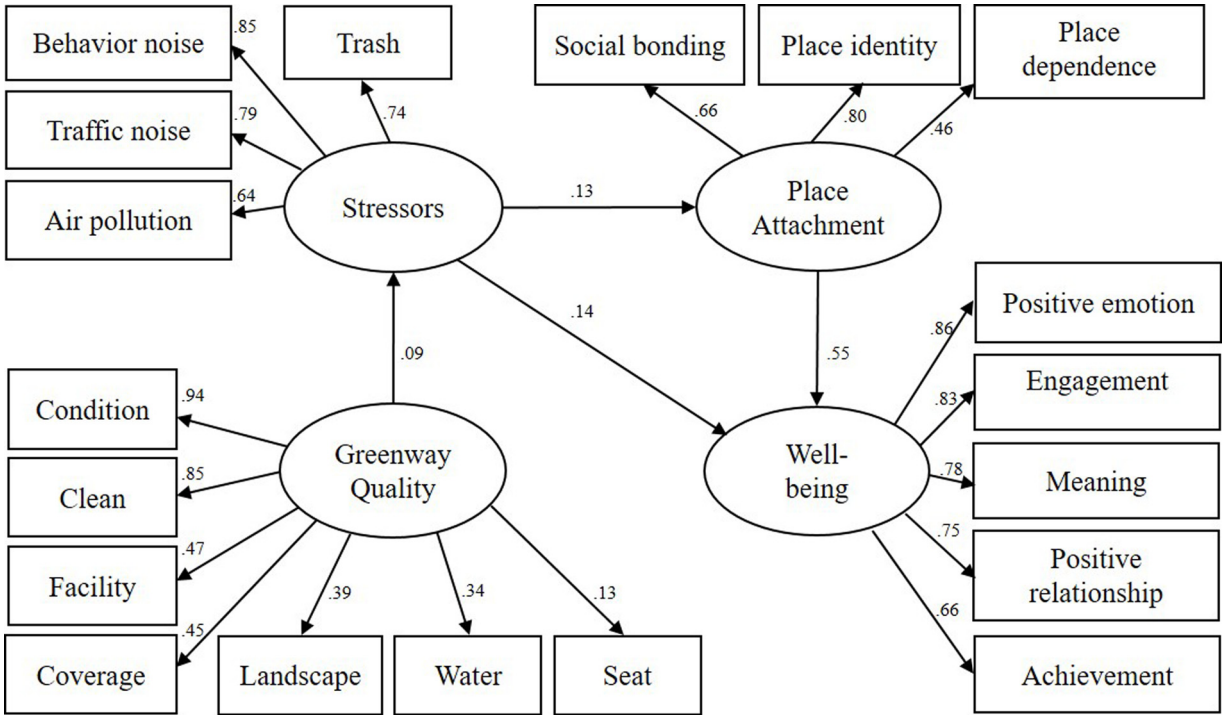

Fig. 2. Standard estimates of Structural Equation Model Path Analysis, controlled by age, education, financial status, and the length of residency. All paths significant at the $p < .05$ level.

Table 5
Bootstrapping effects and 95 % confidence intervals (CI) for the meditational model.

Model pathways	Estimates	Bio-Corrected 95 %CI	
		Lower	Upper
Total effects			
Environmental stressors →Well-being	.258	.158	.368
Indirect effects			
Environmental stressors →Place attachment →Well-being	.038	.007	.093
Direct effects			
Environmental stressors →Well-being	.219	.111	.329

bootstrapping to evaluate place attachment's mediating role. Table 5 indicates that among the relationships between environmental stressors, place attachment, and well-being, no zeroes existed between the lower and upper bounds of the total effect, indirect effect, and direct effect. Additionally, estimates of indirect effect were not zero; therefore, place attachment exerted a mediating effect on the relationship between environmental stressors and well-being, supporting H7.

5. Discussion

This study investigated the relationship between greenways' environmental quality and older residents' well-being. Furthermore, it discussed place attachment's mediating effect on this relationship. The results revealed that greenway quality does not influence well-being directly, but instead positively influences it through environmental stressors and place attachment. In summary, residents' experiences with neighborhood green spaces are the main factor influencing well-being.

First, the results indicate that greenway quality exerts no direct effect on well-being. This finding conflicted with those of previous studies (Akpinar, 2014, 2016a; Luymes and Tamminga, 1995; Searns, 1995), as well as with the suggestion of SRT (Ulrich, 1981). While greenways can compensate for the lack of green spaces in urban developments and provide residents with venues for stress reduction and recreational activities (Fabos, 1995; Little, 1995), the greenway's size might not be large enough for users to enjoy the natural surroundings. Older residents might not seek out greenways to interact with nature, but rather to meet their friends or participate in community activities. Furthermore, previous studies focused on walking behaviors among older urban residents (Sugiyama et al., 2010). The facility in the greenway might not be the most important factor for older residents to do outdoor exercises and, thus, influence their well-being directly. While it is not related to well-being, perceived environmental stressors on the greenway are related positively to place attachment. The findings supported Lewicka (2011) and Moulay et al.'s (2018) proposed model, which asserts that public places' physical effects, such as cleanliness, predict place attachment. Older residents are more willing to access urban greenways if they perceive fewer environmental stressors, resulting in higher place attachment.

Second, the results indicated that place attachment is related positively to well-being. Participants experienced higher levels of well-being when they were more attached to their local greenways. Extant studies support the present study's findings: Older adults feel a sense of purpose and security when they have higher levels of place attachment (Rowles, 1993), which, in turn, improves well-being, thereby achieving aging in place and successful aging (Wiles et al., 2011). In addition, most participants in this study were residents of the same location for over 30 years. They might have developed high place attachment toward their nearby greenways and, thus, reported higher levels of well-being. Place attachment plays an important role in the aging process because it can help older adults maintain self-identity and well-being, as well as a sense of security (Rowles, 1993; Wiles et al., 2011). Furthermore, this study found that place identity contributed the most to the place-attachment dimension. Therefore, it is vital for older adults' well-being that they feel that they are members of their neighborhood communities. Emotional attachment toward their nearby public spaces might be more important than functional and social attachment. This finding supported Tsai's (2016) suggestion that place identity is a critical factor in the connection between humans and their environments. Place attachment not only predicts well-being, but also mediates the

relationship between environmental stressors and well-being. For those with higher levels of place attachment, fewer perceived environmental stressors on greenways improved well-being. This finding supported Zhang et al.'s (2015) finding that place attachment mediated the relationship between urban neighborhood green spaces and psychological health. They indicated that participants are more willing to visit green spaces with good conditions and, thus, perceive greater psychological health benefits from place attachment. Moreover, the findings supported Moulay et al.'s (2018) proposed theoretical framework, which assumes that an urban open space's physical conditions could influence residents' behavioral intentions to use the space through place attachment.

Third, the results indicated that greenway quality is related negatively to environmental stressors, i.e., better greenway quality could prevent environmental stressors among users. The findings corresponded with those from previous studies, which found that the quality of public spaces (e.g., tree-canopy cover and vegetation) reduces noise and air pollution from roads. Reducing environmental stressors is critical because they are related negatively to well-being, i.e., participants reported worse well-being when they perceived more environmental stressors in greenways. The findings corresponded with those from previous studies that found these stressors were viewed as health risks (Adler and Hillhouse, 1996; Marsland et al., 2001) and might weaken residents' willingness to participate in outdoor activities (Dzhambov et al., 2018). In addition, participants who perceived lower environmental-stress levels reported higher place-attachment levels. Therefore, it is crucial to maintain urban green spaces' environmental quality to enable older adults to develop place attachment and improve well-being. The results supported Lewicka's (2011) suggestion that pollution is viewed as a predictor of place attachment in a study of neighborhood environments. Older residents might be less willing to use urban greenways that have higher levels of environmental stressors, giving them fewer opportunities to develop place attachment. As greenways are linear public spaces adjacent to roads, environmental quality might be more important to landscape designers, who then can create high-quality, easy-to-maintain public spaces so that older adults can enjoy the outdoors and improve their well-being, while being protected from environmental stressors.

Finally, the relationship between greenway quality and well-being is formed through participants' perceptions of environmental stressors and through their emotional perspectives on local green spaces. Although some studies found that urban greenways provide an opportunity for older adults to interact with nature, which might improve their well-being (Takano et al., 2002; van den Berg et al., 2010; Wells and Evans, 2003), the present study found that it is more useful to investigate specific experiences—such as perceptions of environmental stressors and place attachment — on greenways than the possibility of generally improved well-being. Specifically, participants who lived near a better-quality greenway might have perceived fewer environmental stressors, thereby likely improving their well-being through engagement with outdoor activities. Greenway conditions contributed most to the dimension of greenway quality, whereas the number of seats available on the greenway contributed least. Participants perceived fewer environmental stressors if greenway conditions were deemed favorable. In addition, participants might have spent more time on greenways that provided more seats and, thus, perceived more environmental stressors there.

More specifically, noise contributed the most to the environmental-stress dimension, whereas air pollution contributed to it the least. Participants who perceived less background noise might have higher levels of place attachment and well-being. Most participants in the current study had lived in their communities for more than 30 years, so they might have become accustomed to traffic noise and litter when engaging in activities on the greenways. However, noise from other people or groups might have annoyed them while sharing spaces with others, thereby influencing their place attachments. Air pollution is a serious problem in Taichung, where air quality was considerably low between March and May 2018: The average value of $PM_{2.5}$ was around 27.489 $\mu g/m^3$, which is unhealthy for sensitive groups, according to the Environmental Protection Agency (EPA). However, it may not have been easy for study participants to perceive air pollution, as it cannot be perceived easily when people are engaged in activities on the greenways.

6. Conclusions and limitations

This study indicated that greenways provide older urban residents with spaces to promote their well-being and facilitate aging in place and successful overall aging. Previous studies paid more attention to behavior or outdoor activities in the relationships between public spaces, place attachment, and well-being. However, we focused on greenway quality as a physical predictor in influencing environmental stressors and place attachment, thereby affecting older adults' well-being. For the older population, engaging in activities in public spaces might not be a crucial factor in improving well-being. Future studies might examine more potential factors to extend this study's knowledge. Additionally, this study aimed to help relieve the crisis of Taiwan's aging society by examining environmental pollution's influence on the relationship between urban green spaces and older adults' well-being. While this research employed experts to evaluate greenways using the EAPRS and distributed self-administered questionnaires, this approach was unable to address the differences between individual greenways or include more geographical information. Future studies should employ a geographic information system to incorporate objective environmental pollution indicators into the research.

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