Underlying relationships between public urban green spaces and social cohesion: A systematic literature review

Abstract

Research has substantiated the positive role of social cohesion on physical health and psychological well-being, and there is increasing interest in how public urban green spaces ("green spaces" hereafter) promote social cohesion. This review synthesized existing available empirical evidence to ascertain the impact of green spaces on social cohesion. 51 published studies met the inclusion criteria were reviewed. Physical characteristics, perceptions, and use patterns of green spaces were found directly influencing social cohesion. Findings also suggested that physical characteristics of green spaces intermingle with environmental perceptions and use patterns to further complicate the impact on social cohesion. A model was proposed to conceptualize the complex relationships between green spaces and social cohesion. The review identified current gaps in the literature where future research is needed. It also informs interventions for promoting public health and well-being by enhancing social cohesion in urban natural environments.

Keywords: green spaces; social cohesion; physical characteristics; environmental perceptions; use patterns; well-being

1. Introduction

Social cohesion is conceptualized as shared norms and values (Beckley, 1995), positive interactions and relationships among individuals (de Vries, Van Dillen, Groenewegen, & Spreeuwenberg, 2013), and feelings of being accepted and belongings (Forrest & Kearns, 2001) in neighborhood settings. A variety of terms such as social contact, social connection, social interaction, social support, and social ties are used to indicate the value of individuals' relations with others in a neighborhood context, and expressions like feelings of loneliness and lack of social support are used to represent absence of social cohesion (Elands, Peters, & de Vries, 2018). Social cohesion is also closely related to the construct social capital (Rios, Aiken, & Zautra, 2012). In line with the practice of Hartig, Mitchell, de Vries, and Frumkin (2014), the term *social cohesion* will be used throughout this study; it is because social cohesion put a heavier emphasis on neighborhood context and is more likely to be affected by physical characteristics of the neighborhood such as green spaces (Hartig et al., 2014; Rios et al., 2012) whereas social capital is more an asset of individuals (Elands et al., 2018).

Research has substantiated the positive role of social cohesion on human health and well-being (Kawachi & Berkman, 2000, 2001). For instance, people are more likely to engage in physical activity given that social cohesion is negatively associated with neighborhood violence (Sampson, Raudenbush, & Earls, 1997; Ferreira et al., 2007). Informal social encounters taken in public spaces help city dwellers relieve from daily routines, reduce tensions, and strengthen personal resilience (Cattell, Dines, Gesler, & Curtis, 2008; Lee, Jordan, & Horsley, 2015). In addition, social cohesion among neighbors is a particularly important aspect of older adults' well-being because it results in a higher degree of social support (Cramm, van Dijk, & Nieboer, 2013) and reduces mortality risks (Inoue, Yorifuji, Takao, Doi, & Kawachi, 2013).

Green spaces have been suggested contributing to social cohesion by encouraging people to go out and providing opportunities and venues for people to others and undertaking social activities (Elands et al., 2018; Swanwick, Dunnett, & Woolley, 2003). Considerable research has examined on the role of the physical environment of the green spaces in facilitating social cohesion. For example, the presence of trees has greater potential to encourage utilization of common spaces and favors positive informal social interactions between visitors (Coley, Kuo, & Sullivan, 1997; Kuo, Sullivan, Coley, & Brunson, 1998; Kweon, Sullivan, & Wiley, 1998). Meanwhile, subjective environmental factors like perceived greenness (de Vries et al., 2013; Sugiyama, Leslie, Giles-Corti, & Owen, 2008) and perception of safety (Dinnie, Brown, & Morris, 2013; Hong, Sallis, et al., 2018) as well as nature dose such as frequency and duration of visiting green spaces (Kaźmierczak, 2013; Shanahan et al., 2016; Mowen & Rung, 2016) have been found crucial in promoting social cohesion.

While studies have investigated the effects of different green spaces' aspects on social cohesion, specific pathways through which factors impact social cohesion have not been systematically synthesized. Besides, current literature has considered different aspects of green spaces as independent factors to social cohesion; no studies hitherto have explored the possibility of interrelations between these aspects and their joint effects on social cohesion. To address the knowledge gaps, the present literature review aims to (1) identify and

summarize different aspects of green spaces that influence social cohesion; and (2) uncover pathways between these aspects and social cohesion. This study will advance our understanding of how green spaces can function as a system of promoting social cohesion. The elucidated mechanisms between the relationships can be strategized as a means of developing and fostering social cohesion. Urban planners can work on interventions and configure green spaces that enhance social cohesion and meet public health challenges of urbanization by drawing reference to the findings.

2. Method

2.1. Search strategy

A keyword searching was conducted on databases Web of Science (WOS) and PubMed to identify empirical research studies in peer-reviewed English language journals published between 1997 and 2018. The search was conducted in July 2019. It focused on literature that examines social cohesion in public urban green spaces. Two groups of search queries were developed and entered in the Advanced Search text box using the field tag "Topic" for publication identification. The first group of search strings contains keywords related to public urban green spaces. Term variations of social cohesion formed the second group of search queries (Table 1). We used Boolean operator OR in between terms and used the Boolean operator AND to link two sets of search results. Asides from keyword searching, additional studies were identified by using backward and forward reference searching when reviewing full texts of included studies.

Table 1. Search query

Search query	Topic terms
1st group of search query	"urban green space*" OR "urban public open space*" OR "urban public green space*" OR "green space*" OR "open green space*" OR "open area*" OR "open space*" OR "neighbo$rhood green space*" OR "neighbo$rhood open space*" OR "neighbbo$rhood park*" OR "greenspace*" OR "neighbo$rhood space*" OR "neighbo$rhood greenness" OR "greenness" OR "urban greenspace*" OR "public greenspace*" OR "green common space*" OR "urban park*" OR "natural outdoor environment*" OR "community garden*"
2nd group of search query	"social cohesion" OR "social coherence" OR "social connection*" OR "social tie*" OR "social capital" OR "social connectedness" OR "social relationship*" OR "social interaction*" OR "social inclusion" OR "social support*" OR "social integration" OR "social contact*"

Note. * = any group of characters, for finding words with any possible ending. $ = zero or one character, for finding the American and British variation of the term.

2.2. Eligibility and study selection

Study selection was divided into three stages. First, search results from WOS database were refined to specific fields of study by using the "Web of Science Categories" provided by the academic database search engine. Studies under categories that are readily irrelevant (e.g., Biology, Neuroscience, Energy Fuels) were excluded in this stage. In the PubMed database, we restricted the results to human studies by using the filter "Species". Second, title and abstract screening was applied to each study after result refinement in the WOS database. The screening aimed to exclude dissertations, conference abstracts, editorials, review articles, and out of scope studies. This process was performed in the PubMed database by first selecting

the filter “Article Type” as Journal Article, followed by title and abstract screening. The third stage is a full-text assessment which has applied to outcomes of both databases. A study had to meet the following criteria in order to be included for the literature review: (i) the investigated setting should be exclusively a form of public urban green spaces (e.g., urban parks, common spaces with vegetated cover); (ii) must have public urban green spaces characteristics, either objective or subjective ones, that are being evaluated for the relationships with social cohesion or similar behaviors; (iii) the outcome measure must be social cohesion or similar behaviors.

2.3. Quality assessment

Included studies were checked for methodological quality by using the Mixed Methods Appraisal Tool (MMAT) (Hong, Pluye, et al., 2018). The tool was developed for quality appraisal of systematic reviews that include qualitative, quantitative, and mixed methods studies. There are five criteria for assessing each category of study (Appendix B). Reviewers evaluate the quality of a study by rating the criteria of the chosen category (“Yes” = *criterion is met*; “No” = *criterion is not met*; “Can’t tell” = *not enough information for evaluation*). A quality score was calculated by adding up the “Yes” scores for each study. Studies were rated as high quality (HQ) if the score was 5, a score of 3-4 represents medium quality (MQ) and below 3 is low quality (LQ). The assessment results are outlined in Appendix A. Overall, most included studies are of medium quality.

2.4. Data abstraction

The following descriptive items were extracted from each study: (i) authors(s); (ii) year of publication; (iii) journal; (iv) case study location; (v) research design; (vi) outcomes assessed (i.e., operationalization of social cohesion or similar behaviors); (vii) study target; and (viii) sample size. Eligible studies were then read through to elicit factors of public urban green spaces that predict social cohesion or similar behaviors. Meanwhile, the relationships between identified factors and social cohesion were sorted out. The process aimed to explore underlying mechanisms that green spaces factors contribute to social cohesion or similar behaviors. To ensure the quality of the data extraction, the work of study selection, quality assessment, and data extraction conducted by one of the authors were checked by another author. Disagreements arising from the checking process were resolved through discussion between authors.

3. Results

3.1. Search outcomes

The keyword search produced 367 studies by WOS and 118 studies by PubMed (Figure 1). The search result was narrowed to 281 studies by excluding articles published in irrelevant “Web of Science Categories” in WOS and non-human studies in PubMed. The title and abstract screening process further removed 212 studies. There were 69 studies that remained for the full-text assessment. By applying the inclusion criteria, 50 studies were relevant for the literature review but 15 of them were overlapped results that should be deleted. An additional 16 studies were identified by using forward and backward reference

when conducting the full-text assessment. A total of 51 studies were included for quality assessment and no studies were excluded after quality assessment.

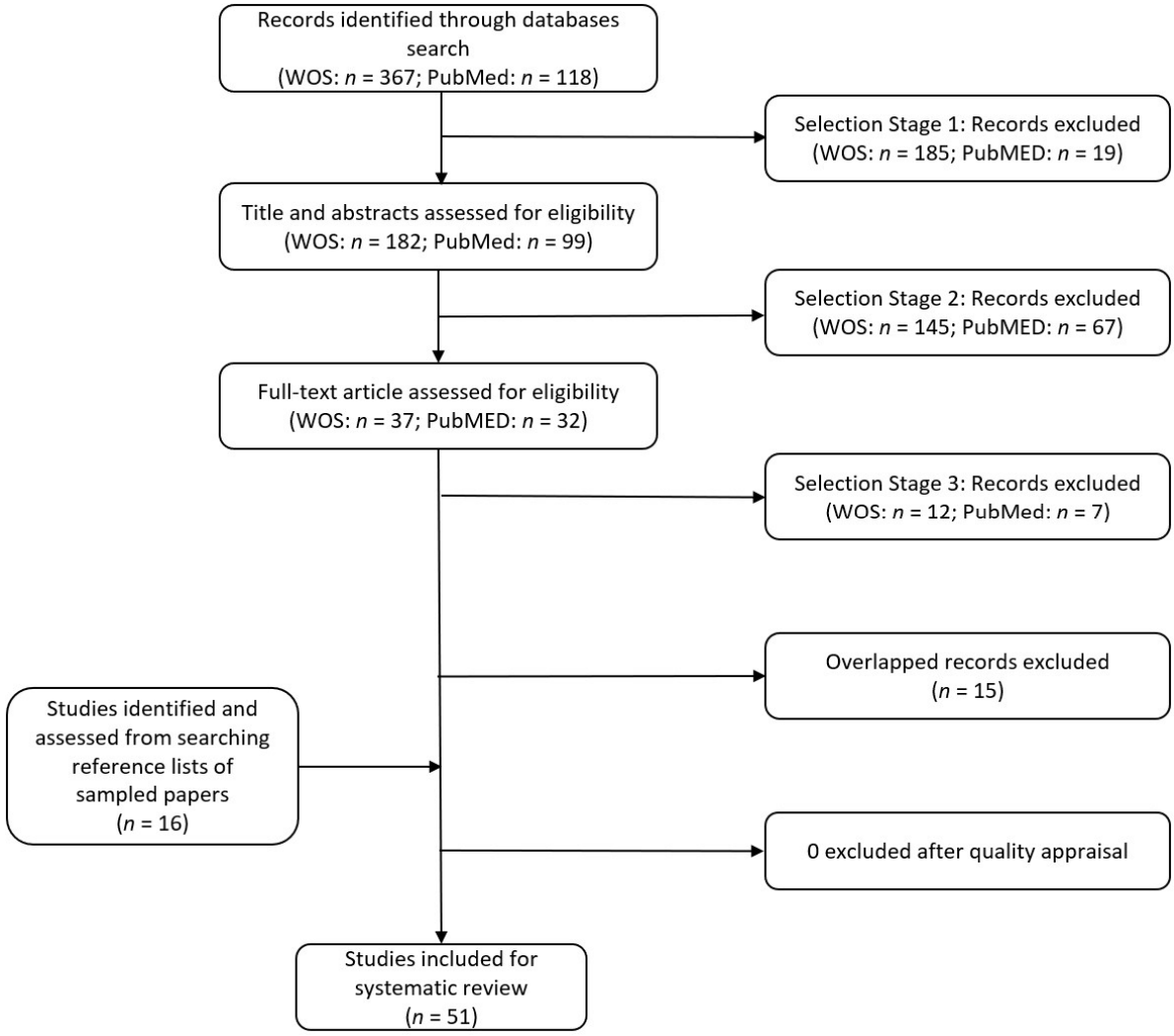

Figure 1. Flow diagram summarizing the search results and screening workflow

3.2. Study characteristics

Table 2 shows the descriptive information of sampled publications. There is a notable difference regarding the distribution of countries where retrieved publications were conducted. Most studies were conducted in Europe (19 publications) and North America (15 publications). The rest of the studies were divided between Asia (China, Malaysia, Japan, and Taiwan), Australia, and South America (Chile, Peru). The 51 studies were published in 28 different journals, and over 45% of them (23 studies) were published in Health & Place, Landscape and Urban Planning, International Journal of Environmental Research and Public Health, and Environment and Behavior. Regarding the methodology used, around 53% of the studies applied quantitative research methods for data collection. Qualitative research literature accounted for about 35% of the included studies. The remaining articles used a mixture of qualitative and qualitative methods. Besides, most retrieved publications were cross-sectional studies.

3.3. Description of outcome assessed

Social cohesion, social interaction, social capital, and social contacts are the most typical terms used for representing the value of individuals' relations with others in neighborhood context. Examples of other terms investigated are social support, social networking, social ties, social relations, social inclusion, and loneliness. Regarding how the outcome variable is being operationalized, nearly 73% of the studies examined the outcome from a single aspect. The remaining studies measured different aspects of the outcome, for example, Maas, van Dillen, Verheij, and Groenewegen (2009) studied social contacts by using the level of loneliness, social support, and extent of social contact. Sugiyama et al. (2008) tested the outcome variable by examining both social coherence and social interaction. Questionnaire items for measuring the outcome variable were partially or fully adapted from one or more validated scales. Among the quoted scales, the Social Cohesion and Trust Scale (Sampson et al., 1997), Reciprocated Exchange (Sampson, Morenoff, & Earls, 1999), a general measure of social capital (Bullen & Onyx, 1998), and Duke-UNC Functional Social Support Questionnaire (Broadhead, Gehlbach, de Gruy, & Kaplan, 1988), UCLA Loneliness Scale (Russell, 1996) were most frequently used. For other studies, self-developed measurements were used for assessing the outcomes.

Table 2. Descriptive information of retrieved publications

Study (year of publication)	Location	Research methods	Operationalized of social cohesion or similar behaviors	Study target	Sample size
Astell-Burt et al. (2016)	AUS	QS	• **Social networking:** 3 items selected from short version of the *Duke Social Support Index* (Koenig et al., 1993)	People living within 5 km of the Western Sydney Parklands	*n* = 7,272
Cattell et al. (2008)	UK	SE, DG, O, SSI	• **Social relations:** everyday encounters with others, causal social exchanges in public spaces, and informal social contact between different ethnic groups	Residents and community activists	*n* = 42 for DG, 6 sites for O, 24 for SSI
Cohen et al. (2008)	US	QS	• **Social cohesion:** 5 items adapted from *Social Cohesion and Trust Scale* (Sampson et al., 1997)	General population	*n* = 2,431
Coley et al. (1997)	US	O	• **Social activity:** social activities of observed residents in green spaces	Residents of public housing	*n* = 96
Cox et al. (2017)	UK	QS	• **Social cohesion:** 17 items adapted from *Social Cohesion and Trust Scale* (Sampson et al., 1997), *Reciprocated Exchange* (Sampson et al., 1999), and a general measure of social capital (Bullen & Onyx, 1998)	General population	*n* = 1,000
Cox et al. (2018)	UK	QS	• **Social cohesion:** items adapted from *Social Cohesion and Trust Scale* (Sampson et al., 1997), *Reciprocated Exchange* (Sampson et al., 1999), and a general measure of social capital (Bullen & Onyx, 1998)	General population	*n* = 3,000
Dadvand et al. (2016)	ESP	QS	• **Social support:** 8 questions of the *Duke-UNC Functional Social Support Questionnaire* (Broadhead et al., 1988)	General population	*n* = 3,461
de Vries et al. (2013)	NLD	O, QS	• **Social cohesion:** 5 items from *Social Cohesion and Trust Scale* (Sampson et al., 1997), 4 items about social quality (Intomart, 2001) and 4 items on social well-being (Völker, Flap, & Lindenberg, 2006)	Neighborhoods' residents	*n* = 1,641 for QS, 320 streets for O

Table 2. Descriptive information of retrieved publications (continued)

Study (year of publication)	Location	Research methods	Operationalized of social cohesion or similar behaviors	Study target	Sample size
Dinnie et al. (2013)	UK	SSI, WI, VF, VR	• **Social interaction:** measuring interaction between different people, e.g., socializing, chatting, connecting with others	Greenspace users	*n* = 10 for all methods
Dzhambov et al. (2018)	BGR	QS	• **Neighborhood social cohesion:** A brief form of the *Perceived Neighborhood Social Cohesion* questionnaire (Dupuis, Baggio, & Gmel, 2015)	Young people	*n* = 399
Fan et al. (2011)	US	QS	• **Social support:** measuring years living in the current house and health interfering with socializing	General population	*n* = 1,544
Gobster (1998)	US	O	• **Activities and interactions** engaged in the park	Park users	*n* = more than 5,000 individuals
Gómez et al. (2015)	US	QS	• **Psychological Sense of Community:** 20 items of 4 subscales including Emotional Connection, Meet Needs/Integration, Membership, and Safety (McMillan & Chavis, 1986)	General population	*n* = 119
Hale et al. (2011)	US	SSI	• **Social networks / social ties / social support:** interactions with neighbors, building social networks, sharing fruits with others, and meeting people in the community	Community gardeners	*n* = 67
Harris et al. (2014)	AUS	SSI	• **Social connectedness / social capital:** a sense of belonging to the community through sharing produce and work collaboratively with others	African humanitarian migrants	*n* = 12
Holtan et al. (2015)	US	QS	• **Social capital:** 5 items measuring neighborhood social connection and association adapted from *Baltimore Ecosystem Study* Telephone survey	General population	*n* = 361

Table 2. Descriptive information of retrieved publications (continued)

Study (year of publication)	Location	Research methods	Operationalized of social cohesion or similar behaviors	Study target	Sample size

A. Hong et al. (2018)	US	QS	• **Social capital:**
			  ○ **Social cohesion:** 5 items adapted from *Social Cohesion and Trust Scale* (Sampson et al., 1997)
			  ○ **Social interaction:** 3 survey items adapted from Parker et al. (2001)
				Older adults	*n* = 647

Hordyk et al. (2015)	CAN	D, ST, SSI	• **Social cohesion:** conversations with neighbors and relationships with friends and acquaintances	Immigrants	*n* = 23 for all methods
Huang et al. (2006)	TW	O	• **Social interaction:** behavioral interaction among residents including nodding, talking, waving, and friendly physical contact	Residents of high-rise housing	*n* = 32,476
Jibril & Elfartas (2018)	MYS	QS	• **Social interaction:** factors adapted from Holland, Clark, Katz, and Peace (2007) and Wagner and Peters (2014)	Urban park users	*n* = 274
Kaźmierczak (2013)	UK	QS, FG	• **Social ties:** number of friends and acquaintances that respondents had in the investigated areas, how they used the park, how they related to other people there, whether they established any new relations as a result of visitation	Residents of inner-city neighborhoods	*n* = 1,450 for QS, 18 for FG
Kemperman & Timmermans (2014)	NLD	QS	• **Social contacts:** 6 statements measuring respondents' relation with neighbors	Older adults	*n* = 1,501
Kingsley & Townsend (2006)	AUS	SSI	• **Social connections and networks:** exploring friendships and support networks among people participating in a community gardening program	Members of community garden	*n* = 10
Korn et al. (2018)	PE	QS	• **Social capital:** using 36 items of eight subscales including participation in the local community, social agency, feelings of trust and safety, neighborhood connections, friends and family connections, tolerance of diversity, value of life, and workplace connections (excluded) from the *Social Capital Scale* (Onyx & Bullen, 2000)	Adult community members	*n* = 44

Table 2. Descriptive information of retrieved publications (continued)

Study (year of publication)	Location	Research methods	Operationalized of social cohesion or similar behaviors	Study target	Sample size
Krellenberg et al. (2014)	CHL	QS	• **Spatial interaction:** contact with different socio-economic status groups	Residents with different socio-economic backgrounds	*n* = 232 household
Kuo et al. (1998)	US	SI	• **Neighborhood Social Ties:** 8 items of 3 subscales including Socializing, Nearby Neighbors, and Local Sense of Community • **General Social Ties:** 2 items measuring residents' broader of social networks (Are you content with the number of close friends you have in general? / Do you have many acquaintances?)	Residents of public housing	*n* = 145
Kweon et al. (1998)	US	SI	• **Social integration:** 15 items measuring social ties with neighbors and friends	Older adults	*n* = 91
Maas et al. (2009)	NLD	QS	• **Social contacts:** measured by *UCLA Loneliness Scale*, *Social Support List* (number of supportive interactions and shortage of social support), and contact with neighbors and friends	General population	*n* = 10,089
Mangadu et al. (2016)	US, MX	FG, II, PV, QS	• **Social support:** interpersonal networks of participants (e.g., "I feel more involved in this neighborhood", "I spend more time with my family", "I have made new friends", "I work better with others on a team")	Community gardeners, parents, youth, individual interviews	*n* = 223
Moulay et al. (2017)	MYS	QS, O	• **Social interaction:** measured by types of interactions (e.g., meeting friends, family gathering), engagement with being in park, and types of contact (e.g., greeting, discussion)	Residents living in the vicinity of parks	*n* = 339 for QS, 2 parks for O
Mowen & Rung (2016)	US	QS	• **Social capital:** measured by social cohesion, informal social control, social leverage, park organization. Measurements were derived from the *Project on Human Development in Chicago Neighbourhoods and the Los Angeles Family and Neighbourhood Survey* (Carpiano, 2007)	Park users	*n* = 238

Table 2. Descriptive information of retrieved publications (continued)

Study (year of publication)	Location	Research methods	Operationalized of social cohesion or similar behaviors	Study target	Sample size
Noone & Jenkins (2017)	UK	O, SI	• **Social bonds / social capital / social interaction:** connections among individuals, social networks and the norms of reciprocity and trustworthiness that arise from them (Putnam, 2000)	People with dementia, day center staff	*n* = 13
O'Brien et al. (2010)	UK	O, I, FG	• **Social capital / Social networks:** participants' relations with family and/or their local community	Socially marginalized people	*n* = 88 for O and I, 10 for FG
Orban et al. (2017)	DE	QS	• **Social relations:** o **Social satisfaction:** 1 item (How satisfied are you with your relations to friends, neighbors, acquaintances?) o **Neighborhood social capital:** 1 item (How satisfied are you with your residential area?)	Participants of the Heinz Nixdorf Recall study conducted in three adjacent cities in Germany	*n* = 4,480
Peters (2010)	NLD	O, SSI	• **Social interaction:** familiarity with spaces, regular use, and conversations between strangers	Native Dutch and immigrants park visitors	*n* = 26 for O, 40 for SSI
Peters et al. (2010)	NLD	QS, I, O	• **Social cohesion:** social interaction and place attachment	Native Dutch and immigrants	*n* = 618 for QS, 40 for I, 26 for O
Pleson et al. (2014)	TW	O, SI	• **Social engagement:** activities of social engagement that occur at the community green spaces, e.g., social interactions, socializing, chatting with friends	Older adults	*n* = 1,227 for O, 19 for SI
Ruijsbrock et al. (2017)	ESP, UK, NLD, LTU	QS	• **Social cohesion:** 5 items adapted from *Social Cohesion and Trust Scale* (Sampson et al., 1997) • **Neighborhood attachment:** 3 items (I feel attached to this neighborhood / I feel at home in this neighborhood / I live in a nice neighborhood were people have a sense of belong) • **Social contacts:** 1 item (How often you had contact with your neighbors?)	General population	*n* = 3,771

Table 2. Descriptive information of retrieved publications (continued)

Study (year of publication)	Location	Research methods	Operationalized of social cohesion or similar behaviors	Study target	Sample size
Seeland et al. (2009)	CHE	QS	• **Social inclusion:** questions asking about pupils' peer groups and ways of making friends	Young people	*n* = 437
Shanahan et al. (2016)	AUS	QS	• **Social cohesion:** 17 items adapted from *Social Cohesion and Trust Scale* (Sampson et al., 1997), *Reciprocated Exchange* (Sampson et al., 1999), and a general measure of social capital (Bullen & Onyx, 1998)	General population	*n* = 1,538
Soga et al. (2017)	JPN	QS	• **Social cohesion:** 5 items adapted from *Social Cohesion and Trust Scale* (Sampson et al., 1997)	Allotment gardeners and their neighbors	*n* = 332 (165 gardeners, 167 non-gardeners)
Sugiyama et al. (2008)	AUS	QS	• **Social coherence:** 6 items adapted from the *Neighborhood Quality of Life Study* (du Toit, Cerin, Leslie, & Owen, 2007) and *Social Cohesion and Trust Scale* (Sampson et al., 1997) • **Social interaction:** the number of days participants performing various informal social activities in the past month	Adults	*n* = 1,895
Sullivan et al. (2004)	US	O	• **Social activity:** 6 general categories of social activity in green spaces including eating, doing chores/repairs, socializing, entertaining, resting/thinking, and playing	Residents of inner-city neighborhoods	*n* = 758
Teig et al. (2009)	US	SSI	• **Social processes:** social connections, reciprocity, mutual trust, collective decision-making, social norms, civic engagement, community building, volunteer activity, leadership activity, organized neighborhood activity, recruitment activity	Members of community garden	*n* = 47
Triguero-Mas et al. (2015)	ESP	QS	• **Social support:** 11 questions of the *Duke-UNC Functional Social Support Questionnaire* (Broadhead et al., 1988)	General population	*n* = 8,793

Table 2. Descriptive information of retrieved publications (continued)

Study (year of publication)	Location	Research methods	Operationalized of social cohesion or similar behaviors	Study target	Sample size
Ulmer et al. (2016)	US	QS	• **Neighborhood social cohesion:** 3 questions on neighborhood social cohesion	General population	*n* = 7,910
van den Berg et al. (2010)	NLD	QS	• **Loneliness:** 2 items measuring the frequency of feelings of loneliness and the need for social contacts • **Social contacts with friends:** 2 items measuring the frequency of contacts with friends and the size of one's circle of friends	Allotment gardeners and their neighbors	*n* = 184 (121 allotment gardeners, 63 non-allotment gardeners)
Veen et al. (2015)	NLD	QS, SSI	• **Width of social cohesion:** 3 items (The degree to which people know other participants / The number of garden acquaintances participants have / The extent to which they speak to others) • **Depth of social cohesion:** 1 item (The degree to which participants engage in mutual help)	Members of community garden	*n* = 237 for QS, 63 for SSI
Whatley et al. (2015)	AUS	O, SSI	• **Social inclusion:** inquiring participants how does a neighborhood-located gardening program create a socially inclusive environment (e.g., bringing people together, creating connections in the wider community, working with each other)	Community garden's staff, participants, external support worders, volunteers	*n* = 13 for O, 6 for SSI
Zhang et al. (2018)	CHN	QS	• **Social health:** 5 items adapted from *Social Cohesion and Trust Scale* (Sampson et al., 1997), *Social Wellbeing Scale* (Völker et al., 2006) and *Social Support List-Interactions* (Kempen & Van Eijk, 1995)	Adult residents	*n* = 1,003

Table 2. Descriptive information of retrieved publications (continued)

Study (year of publication)	Location	Research methods	Operationalized of social cohesion or similar behaviors	Study target	Sample size
Zijlema et al. (2017)	ESP, NLD, UK	QS	• **Social interaction:** 1 item (How often do you have contact with your neighbors?) • **Loneliness:** 6 statements based on *UCLA Loneliness Scale* (Russell, 1996) • **Neighborhood social cohesion:** 5 items adapted from *Social Cohesion and Trust Scale* (Sampson et al., 1997)	General population	*n* = 1,628

Note. For brevity, the column of journal was not presented in this table. Country code: AUS = Australia; BGR = Bulgaria; CAN = Canada; CHE = Switzerland; CHL = Chile; CHN = China; DE = Germany; ESP =Spain; JPN = Japan; LTU = Lithuania; MYS = Malaysia; MX = Mexico; NLD = Netherlands; PE = Peru; TW = Taiwan; UK = United Kingdom; US = United States. Research methods code: D = Drawing; DG = Discussion Groups; FG = Focus Group Interview; I = Interview; II = Individual Interview; O = Observation; PV = Modified Photovoice methodology; QS = Questionnaire Survey; SE = Scoping Exercise; SI = Structured Interview; SSI = Semi-structured Interviews; ST = Story-telling; VF = Video Filming; VR = Video Review; WI = Walking Interviews.

3.4. Identified green spaces' aspects and their impacts on social cohesion

Relationships between social cohesion and different aspects of green spaces had been examined. There are three major aspects of green spaces contributing to the development of social cohesion, namely, physical characteristics, perceptions of the environment, and use patterns. Appendix C shows the distribution of these factors mentioned by the included studies. The rest of this section will report the findings.

3.4.1. Physical characteristics

A robust literature has established a significant association between the ***presence of vegetation*** and various forms of social process (e.g., de Vries et al., 2013; Holtan, Dieterlen, & Sullivan, 2015; Ulmer et al., 2016; Zhang, Zhou, Kwan, Fei, & Lin, 2018; Jibril & Elfartas, 2018; Kweon et al., 1998; Sullivan, Kuo, & DePooter, 2004). The presence of trees and grass was suggested to encourage greater use of outdoor spaces, thereby increasing the possibility of informal social contact with others (Coley et al., 1997). A subsequent research (Kuo et al., 1998) proved that the level of vegetation is positively associated with the use of common spaces and social ties among respondents; the study also empirically confirmed the mediating role of use in the relationship between vegetation and social ties. Other research literature has reported the impact of vegetation on different aspects of social cohesion. Living environment with more parks is strongly associated with a higher level of reported social cohesion (Cohen, Inagami, & Finch, 2008). Sidewalks with trees are especially important to immigrants because they provide an attractive and pleasant environment for people to linger a while; immigrants usually start conversations and nurture social relationships with neighbors and acquaintances there (Hordyk, Hanley, & Richard, 2015). Moreover, individuals living in a more vegetation-covered environment were found feeling less lonely (Maas et al., 2009), receiving more social support (Maas et al., 2009; exception see Fan, Das, & Chen, 2011; Dadvand et al., 2016), and increased neighborhood social capital (Orban, Sutcliffe, Dragano, Jöckel, & Moebus, 2017). Despite the significant association reported by these studies, a few research (Ruijsbroek et al., 2017; Triguero-Mas et al., 2015) could not replicate the finding.

Literature has investigated the influence of ***distance*** to green spaces on social cohesion. A significant negative relationship between residential distance to natural outdoor environment and neighborhood social cohesion was proved by Zijlema et al. (2017). According to Coley et al. (1997), trees closer to residences promote greater use of outdoor spaces by mixed age groups comprising adults and youth. The authors inferred from the finding that a close distance of trees results in more people spending time in outdoor spaces, which creates ongoing opportunities for social interactions among neighbors. Moreover, visitors in nearby green spaces are usually from surrounding residences; people are more likely to get a feeling of comfort, familiarity, togetherness, and get acquainted with neighbors when using green spaces, resulting in the possibility of enhanced social cohesion (Peters, 2010). Meanwhile, some studies have revealed that the objective measurement of distance does not significantly influence social support (Dadvand et al., 2016; Fan et al., 2011; Astell-Burt, Feng, & Kolt, 2015) or social cohesion (Dzhambov, Hartig, Markevych, Tilov, & Dimitrova, 2018).

Compared to vegetation and distance, the ***size*** of green environments relevant to social cohesion received less attention. A larger area supports for more social activities. Peters (2010) observed that visitors in a bigger size park in the Netherlands tend to have more social contact with other visitors through different activities whereas users in a small neighborhood park merely socialize with their groups without bothering others. Fan et al. (2011) empirically proved that park acreage has a significant effect on both physical activity and social support, and the positive impact on social cohesion is even greater than those of neighborhood vegetation level. However, Peters, Elands, and Buijs (2010) found no remarkable differences in terms of the intensity of interactions regardless of the size of parks, though there is contact among people in both neighborhood and bigger size parks.

Accessing to different ***types of green space*** may have significant effects on the intensity of social contact and social relationships with others. For example, community gardens and allotment gardens are guaranteed for bringing people from diverse backgrounds together and creating opportunities for socialization (Kingsley & Townsend, 2006; Teig et al., 2009; van den Berg, van Winsum-Westra, de Vries, & van Dillen, 2010; Veen, Bock, van den Berg, Visser, & Wiskerke, 2016; Whatley, Fortune, & Williams, 2015). It is the social processes such as involvement in garden-related activities, exchange of information, sharing advice about gardening practices that contribute to the development of social ties with other participants. Meanwhile, Holtan et al. (2015) discovered that only urban tree canopy remarkably contributes to social capital while the presence of parks and green yards have no significant association with self-reported social capital in their study conducted in Maryland, the United States. To conclude, it is unlikely that every type of green space is capable of facilitating social cohesion.

Layout and structure affect our perceptions of the environment and the intention we would like to socialize with others. Kingsley and Townsend (2006) noted that layout and design can promote social interactions and connection among gardeners in the community garden. Taking Finlathen Park located in the United Kingdom as an example, Dinnie et al. (2013) illustrated that a more natural and quieter environment resulted from the park's layout and location gives rise to safety concern and lowers the utilization rate, reducing the levels of involvement with others. Recently, Moulay, Ujang, and Said (2017) conducted surveys in neighborhood parks in Malaysia and found that parks with higher clarity of structure positively influence duration of use and contribute to social interactions among park users.

Facilities on offer is a prerequisite for developing quality social interactions in public spaces (Cattell et al., 2008). Research literature has provided a positive relationship between the supply of facilities and various forms of social processes. For instance, community gardens are in itself a place where participants can build up new friendship over an interest of gardening, share their produces with others, spend more time gardening with their families, and meet their neighbors, which all contribute to improved social ties and social support (Hale et al., 2011; Mangadu, Kelly, Orezzoli, Gallegos, & Matharasi, 2017; Noone & Jenkins, 2017). Moreover, the availability of benches, tables, and playground facilities in community gardens forms a social friendly area where individuals can socialize with each other (Kingsley & Townsend, 2006). Provision of playgrounds not only increases social

interactions among children but also interactions between their guardians (Huang, 2006). Revealed by respondents of a focus group discussion conducted in the United Kingdom, bleak landscape which is lack of facilities would limit the use of park for pleasure and opportunities of social interactions (Kaźmierczak, 2013). In contrast, parks with a full range of facilities serve diverse users, providing opportunities for contact between people with different racial and ethnic backgrounds (Gobster, 1998). In sum, facilities in green spaces encourage visitations and promote social interactions among visitors. They are indispensable in promoting social cohesion in urban green environments.

Well maintenance of green spaces promotes their use as recreational areas and realizes the potential of supporting social interactions (Kaźmierczak, 2013). Poor-managed green spaces would have negative impact on the evaluation of the environmental quality and intention of use, together they are not conducive to the development of social cohesion. For example, green spaces that are poorly managed would be perceived as unsafe and visually low quality that affect outdoor activity, which in turn fails to support social contact among neighbors (Kemperman & Timmermans, 2014). By contrast, well-maintained green spaces were found to be frequently visited by all status groups, and are significant for the enhancement of interactions between different socio-economic status groups (Krellenberg, Welz, & Reyes-Päckeb, 2014).

3.4.2. Perceptions of the environment

Physical milieu can influence individuals' perceptions of green spaces. Literature showed that perceptions of the environment significantly relate to social cohesion. The psychological aspect here is concerned with subjective evaluations and personal judgment of the physical environment. They may even be stronger in predicting social cohesion compared to objective features of the environment (e.g., Dadvand et al., 2016; de Vries et al., 2013). In this review, perceived greenness, perceived proximity, and perceived safety were identified as commonly investigated perceptions of the environment that predict social cohesion.

Perceived greenness is the subjective evaluation of the green spaces. Sugiyama et al. (2008) emphasized the importance of green spaces quality such as aesthetic pleasantness and its impact on social cohesion; the study added the quality of the environment into the greenness construct and found that social cohesion is more likely to occur if the places were perceived to be greener and more natural. According to findings by de Vries et al. (2013), the quality of street greenery added predictive value and made the quantity measurement redundant in predicting social cohesion. Greenness can motivate participation in outdoor activity and facilitate social contact among neighbors. Thus, older respondents in the Netherlands (Kemperman & Timmermans, 2014) and in the United States (Hong, Sallis, et al., 2018) were found to have more social contact with their neighbors if they possessed a higher level of perceived greenness. Besides older people, a positive linear relationship was found among young participants (aged 15-25) in a study conducted in Plovdiv, Bulgaria (Dzhambov et al., 2018). Recently, Ruijsbroek et al. (2017) put the construct in a wider context for testing; among four surveyed European cities, the positive influence of perceived greenness on social cohesion was further confirmed in the city of the Netherlands and the United Kingdom.

Perceived proximity**,** referred as the psychological distance to the green spaces, positively affects the use of and social benefits derived from the green spaces. Unlike the objective measured *distance*, the subjective measurement indicated a consistent result across studies. Gómez, Baur, Hill, and Georgiew (2015) found that perceived proximity significantly contributes to the development of a psychological sense of community, a concept primarily related to the feeling of belonging to a group. According to the authors, a perceived barrier-free physical environment promotes greater use and a higher psychological sense of community. A readily available green environment is important to teenagers for socialization. In Switzerland, the development of inter-racial friendships between pupils is related to participation in urban forests and parks that are perceived as easily reached (Seeland, Dübendorfer, & Hansmann, 2009). More important, Dadvand et al. (2016) confirmed that it is subjective residential proximity rather than objective proximity associated with perceived social support. The finding provides evidence to the argument that perceptions of the environment may have stronger power than objective measurements in predicting behaviors and benefits of green spaces.

Perceived safety is a primary concern when deciding whether to visit green spaces or not. Green spaces perceived to be safe are likely to cultivate social interactions. Perceived safety has been considered as one of the quality attributes that encourages greater use of natural environments and leads to enhanced social cohesion (Jibril & Elfartas, 2018). Parents were found to get more spare time and opportunities to socialize with others in a safe green environment where minimal supervision for their children is needed (Kingsley & Townsend, 2006). The perceived pedestrian safety has showed a significant beneficial effect on both social interactions and social cohesion among older adults in green spaces in America (Hong, Sallis, et al., 2018). Nevertheless, the perceived threat of personal safety sets barriers and hinders people from using green spaces. For example, threats such as harassment or a feeling of being unsafe reduce the time spending in green areas (Dinnie et al., 2013) or limit the necessary activities in the spaces (Kaźmierczak, 2013). As a result, the effects of green spaces in facilitating social interactions among individuals may be mitigated.

3.4.3. Use patterns

To understand how social cohesion is cultivated in green spaces we must get insight into the ways that individuals participate in there. Patterns and intensity of use become all the most important in determining the levels of social relationships. Current literature has provided extensive evidence of visitation behaviors on social cohesion. The use patterns have been predominantly operationalized as frequency of use, duration of visitation, type of activities, and public participation in green spaces.

Frequency of use refers to how often people make a visit to the public urban green environments. Frequent visit increases the opportunities to interact with others. Routine social encounters can maintain ties between neighbors (Cattell et al., 2008). In this connection, regular visitors tend to have more friends in the neighborhood (Kaźmierczak, 2013). Frequent visitors were also found to have higher perceived social cohesion (Shanahan et al., 2016; exceptions see Gómez et al., 2015 and Soga, Cox, Yamaura, Gaston, Kurisu, & Hanaki, 2017; Mowen & Rung, 2016; Cox et al., 2017; Cox, Shanahan, Hudson, Fuller, &

Gaston, 2018). By contrast, low frequency of visit may weaken the role of the green environments as spaces for developing social interactions (Kaźmierczak, 2013). Moreover, the frequency of visit was suggested to be affected by physical characteristics of green spaces such as distance (Zijlema et al., 2017) and the presence of vegetation (e.g., Coley et al., 1997; Kuo et al., 1998).

Social cohesion is also subject to the ***duration of visit*** to green spaces. The length of time that people spend in green spaces determines the quality and strength of social relationships with others (Kingsley & Townsend, 2006). Studies revealed that the number of acquaintances (Kaźmierczak, 2013) and perceived social cohesion (Cox et al., 2017; Cox et al., 2018; Mowen & Rung, 2016; Shanahan et al., 2016) will be higher if people spent more time in green spaces. Despite the fruitful evidence, the duration of visitation is not always a stable predictor of social contact (Kweon et al., 1998) or social cohesion (Soga et al., 2017). Besides, perceptions of the environments can influence the time spending in green spaces. Dinnie et al. (2013) observed that perceived safety affects duration of visit, leading to either just walking through or never entering into green spaces.

Activities in green spaces afford opportunities for socialization and connecting people (Dinnie et al., 2013; Peters, 2010; Teig et al., 2009; Pleson et al., 2014; O'Brien, Burls, Townsend, & Ebden, 2011). Different types of activities undertaken in green spaces may have varying effects on interactions and social ties. Mowen and Rung (2016) emphasized that exchanges take place more easily if park visitors had sedentary activities. It is because sitting around provides park visitors with opportunities for face-to-face social contact; by contrast, park users having active activities such as running may not encourage socialization between people because of the limited time of using recreational facilities. Besides, engaging in social activities held in green spaces can facilitate social interactions and strengthen social ties. Immigrants found it particularly important because activities invite them to be outdoor and offer them unique opportunities for meeting others from their home country (Hordyk et al., 2015). Sharing of produce and work collaboratively with other members of community gardens help refugees build community connections and social connectedness in new countries (Harris, Minniss, & Somerset, 2014). Visitors engage in social activities tend to have a higher number of acquaintances compared to those only with necessary activities (e.g., to pass through on the way elsewhere) (Kaźmierczak, 2013). The finding echoes the work by Huang (2006) that spaces designed for activities can support more social interactions. Moreover, the layout of green spaces such as the design contributes to the differences of activities because it facilitates certain kind of activities but also limits other kind of activities (Peters et al., 2010).

Public participation was found to affect the use of green spaces and social interactions among users (Peters et al., 2010). People were found to be more familiar with green spaces and have increased social interactions with different ethnic groups if they participated in the design work of the spaces (Peters et al., 2010). Participating in the operation of community gardens such as securing funds for garden development (Teig et al., 2009) and working together to maintain paths (Veen et al., 2016) was suggested to cultivate social processes and deepen social cohesion among neighbors. Residents of urban slums would be benefited from

improved mental health because of the increased overall social capital as a result of participating in the construction processes of household gardens (Korn et al., 2018). In general, social cohesion is observed in green spaces where active public participation is taken place.

4. Discussion

4.1. Underlying pathways between green spaces and social cohesion

Three aspects of green spaces were found to have ***direct impact*** on the development of social cohesion. Physical characteristics including the presence of vegetation, distance, size, type of green spaces, layout and structure, facilities, and maintenance in general significantly predicted social cohesion although conflicting findings were reported by a few numbers of studies. Since the context of included studies is culturally and geographically diverse, socio-demographic variations, cultural backgrounds of the targeted population, or different aspects of social cohesion being measured may be responsible for the deviated results. Aside from the objective aspect, subjective factors do matter in determining the degree of social cohesion. Perceptions of greenness, proximity, and safety of green spaces have been linked to social cohesion. Research literature also found that our behaviors in green spaces such as frequency of visit, duration of visit, activities taken place, and participation in green spaces create opportunities for and facilitate social processes among visitors.

Meanwhile, it is possible that physical environment of green spaces might affect social cohesion via ***indirect pathways***. We inferred that perceptions of the environment and use patterns may mediate the relationships between physical characteristics and social cohesion. The mediating role of perceptions of the environment was implicitly mentioned by some reviewed studies. Physical characteristics shape the ways we evaluate the green spaces and result in varying degrees of social cohesion. For example, the presence of parks in the neighborhood may perceive as threat of crime or unappealing; the green space would therefore not serve as an agent of providing opportunities for informal interactions and hence not facilitating the creation of social capital (Holtan et al., 2015). Kemperman and Timmermans (2014) highlighted that maintenance of green spaces affects perceived greenness which has been proven to be of major importance for social contact between investigated residents. These examples illuminated the potential role of perceived environment mediating the relationships between physical characteristics and social cohesion. Regarding the use patterns, physical characteristics may determine our use behaviors and in turn affect social cohesion. For instance, lack of facilities reduces both the intention of use and the chances of social contact (Kaźmierczak, 2013). Moulay et al. (2017) proved that a higher clarity of structure increases the length of visitation, which is positively connected to social interactions among individuals. Some research literature has put a step forward and conducted a mediation test (Kuo et al., 1998; Kweon et al., 1998); the results indicated that the presence of trees increases greater use of common space and in turn enhances social ties among neighbors. Thus, it is confident to suggest that use patterns mediate the impact of physical characteristics on social cohesion in green spaces.

Aside from single mediation, the indirect pathways from physical characteristics of green spaces to social cohesion may involve serial mediation (cf. Dzhambov et al., 2018). Rather than considering perceptions of the environment and use patterns as independent mediators, a more complex relationship between the two sets of mediators was observed and it has been subtly discussed by some reviewed studies. Specifically, physical characteristics were suggested to influence perceptions before affecting use patterns, which in turn cultivate social cohesion (i.e., physical characteristics → perceptions → use patterns → social cohesion). For example, poor layout and location of the green spaces give rise to safety concern and result in "pass-through" visiting behavior or lower the desire to engage in the green spaces, which has been suggested to be unfavorable for social interactions (Dinnie et al., 2013). Alternatively, physical characteristics may affect the use patterns first and then the perceptions of the environment, which in turn influence the development of social cohesion (i.e., physical characteristics → use patterns → perceptions → social cohesion). As Krellenberg et al. (2014) has found, the provision of well-maintained facilities contributes to intensive use of green spaces, and results in a higher valuation of green spaces and favors social interactions as well. Therefore, two sets of identified mediators are potential antecedents of each other and form serial mediations in between the relationships. They may facilitate or inhibit the effects of physical characteristics on social relationships in green spaces.

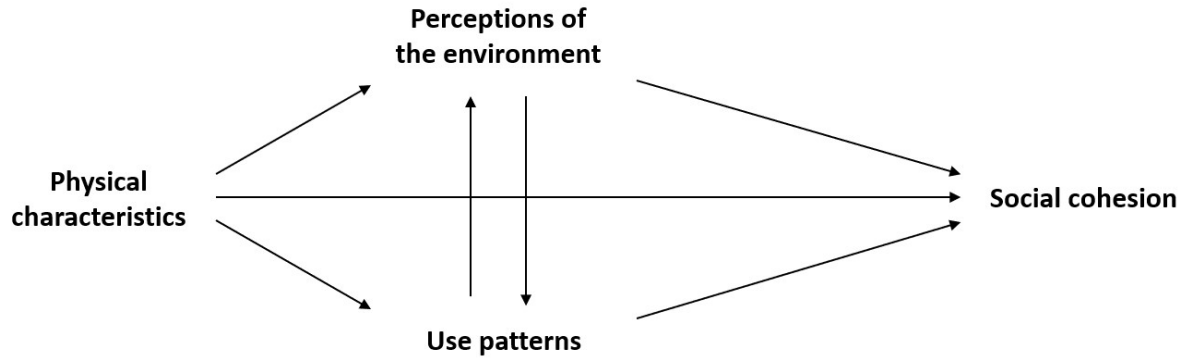

Figure 2. A model conceptualizing the relationships between different aspects of green spaces and social cohesion

To conceptualize the relationships between different aspects of green spaces and social cohesion, a model based on evidence synthesized from reviewed studies and our inferences was proposed (Figure 2). Direct impact of physical characteristics, perceptions of the environment, and use patterns on social cohesion was empirically proved. Meanwhile, perceptions and use patterns were considered as potential mediators that further explain mechanisms behind the relationships. Moreover, the potential mediators may work as antecedents of each other and form serial mediation in between the relationships. Although only a few numbers of studies have empirically tested the proposed single and serial mediation pathways, the inferred relationships provide a foundation for further investigation and discussion in the future by unpacking the impact of green spaces on social cohesion. Apart from the direct impact, the proposed parsimonious model demonstrates how social cohesion in green spaces may be jointly affected by the intermingling of physical settings, perceptions of the environments, and the ways we use the green spaces. The model advances

our understanding of the complex influences of green spaces on social cohesion while informing the development of possible interventions for more green space visitation and positive social interactions with others.

4.2. Recommendations for policy makers

Physical structures of green spaces remain core factors contributing to the development of social cohesion. The presence of vegetation is positively associated with the use of green spaces and social cohesion. Both the amount and quality of greenery need to be increased for making the public spaces more attractive, thereby providing a favorable environment for social interactions. Meanwhile, unmaintained vegetation may cause safety concern (Sreetheran & van den Bosch, 2014) which highlights the importance of maintenance issue. Sound maintenance not merely improves safety perception but increases aesthetic quality of the environment which is a pre-condition of engaging in green spaces and nurturing social interactions. Besides, the provision of a full range of facilities that serve different groups of people would have important consequences for cultivating social cohesion. The facilities increase the attractiveness and utilization of green spaces by people with different backgrounds.

Land resources are valuable, especially in highly urbanized areas. Adding or relocating green spaces may not be a prioritized option for promoting social cohesion but changing the form of green spaces may have implications for the enhancement of social cohesion. Community garden is a form of green spaces in urban societies which almost by definition encourages social interactions among participants (Hartig et al., 2014). By participating in activities held in the community gardens, people get more opportunities to chat with neighbors, provide mutual help to each other, and share information on common interest; a sense of community is expected to increase accordingly. Thus, we suggest setting up more community gardens, especially within those urban parks which have a low utilization rate. In this connection, these urban parks would become more vibrant and less threatening if gardening activities were taken place there. The improved environment would encourage greater use and create additional opportunities for social contact among users. In addition, the provision of pocket neighborhood parks would be another possible solution. On one hand, visitors of pocket parks from nearby residential areas tend to be more familiar with the environment and other users from the community, and thereby increasing the possibility of more social contact among visitors. On the other hand, the provision of pocket parks shortens the geographical distance and minimizes unequal access to green spaces.

The current study suggested that perceptions of the environment and use patterns may mediate the relationships between green spaces and social cohesion. Interventions targeted at these two factors may be more flexible and effective in cultivating social cohesion. Positive perceptions of the environment contribute to a higher level of social cohesion. As revealed from the findings, landscape architects should make it a priority to address people's perception of greenery, proximity, and safety. To improve the quality of planting greenery and provide more information on the location of green spaces could increase the overall attractiveness of and shorten the psychological distance to the spaces. Regarding the

perception of safety, a sufficient lighting system and a clean environment are prerequisites for acquiring a sense of security which is positively connected to social cohesion.

Use patterns are connected to social contact and interactions among visitors. Promoting both frequency and duration of visit would be important for nurturing social cohesion. For instance, organizing social-oriented activities such as festival events in green spaces not only attract more visitors and connect people from different backgrounds but also keep them to stay longer in the green spaces, in turn creating more opportunities for social contact. In addition, given that public involvement such as participating in design work of the environment was found relevant to social cohesion, incorporating constructive public input into green spaces planning would create a hybrid mode of public participation that engages citizens from different spheres and values. The continuing participatory processes and collaboration between citizens and management officials imply that different parties meet the need of each other rather than forcing one to fit the patterns set by any of the parties; the decentralized decision-making process also builds and fosters trust among different parties. Overall, social cohesion in green spaces is a complex phenomenon which could be jointly shaped by different aspects of the environment.

Despite the identified aspects of the green environment, policymakers should aware the impact of contextual and cultural factors which may limit the generalizability of the inferences and prompt framework refinements. For example, living context around the green spaces such as traffic volume and pedestrian infrastructure can potentially influence park use (Baran et al., 2014), which in turn complicates the already complex relationship identified in this review. Cultural factors such as to avoid seeking support from others for saving face and maintaining norms may significantly influence variations in social cohesion (Thoits, 2011). Demographic profile of park users is another major concern. Gender and age structure, for instance, have been found to moderate the association between green space and mental health (Bos, van der Meulen, Marieke, & Jeronimus, 2016). The findings suggest that only certain demographic groups may have the opportunity to make use of their green living environment and thus influence the development of social cohesion across population groups. Policymakers should therefore take into account of context-specific variations and the associated impact on social cohesion when formulating strategic interventions.

4.3. Limitations and recommendations for researchers

There are limitations in the present study that may cause the conclusions deviated from accuracy and comprehensiveness. First, keyword search has its limitations in article collection. For example, studies may not mention the proposed keywords in their title, abstract, or keywords section. As a result, researchers are not able to retrieve relevant studies for literature review. The limitation suggests that using different sources to retrieve articles is preferred. Second, conflicting results were found in some identified factors and the differences may reduce the generalization power of the proposed model. As suggested in the discussion section, the conflicting results may be due to the diverse study context, socio-demographic differences of respondents, and cultural backgrounds. Future studies may benefit from taking factors other than those related to green spaces into consideration.

Regarding the future research direction, first, reviewed studies are predominated by cross-sectional that the extent to which green spaces' impact on social cohesion is unknown. Future studies are suggested using more longitudinal methods to investigate the dynamics of social cohesion taken place in green spaces. Second, although indirect impact was discussed between physical characteristics and social cohesion, whether the impact is fully mediated by single mediator or by serial mediation remains unclear. The question would be important for future research direction. Third, the direction and strength of the relationships between green spaces and social cohesion could be further complicated by taking moderating effect into consideration. For example, physical aspects of green environments such as vegetation density can increase the strength between the duration of green spaces visit and social contact with neighbors in an older adults' community in Chicago (Kweon et al., 1998). Other than interplay among identified aspects, context of the study as mentioned in previous section such as contextual, cultural, and demographic factors may also interact with the green space environment and in turn influence the degree of social cohesion. The evidence and observations suggest that the moderating effect in between the relationships is possible and warrants further investigation in the future.

5. Conclusion

Physical characteristics of green spaces are important for the development of social cohesion, but the objective features are not in itself a sufficient basis for concluding the values of social relationships in green spaces. This study provided a review on other possible green spaces' aspects that account for the development of social cohesion; they are perceptions of the environment and use patterns. The study highlighted how these three aspects relate to each other and influence social cohesion through direct influence, single mediation, or serial mediation, advancing our understanding of social cohesion and its relationship with green spaces. Practically, identifying factors accounting for the development of social cohesion in green spaces provides useful information for city planners to promote human health and well-being. The exploration of pathways connecting green spaces and social cohesion also helps formulate intervention strategies for improving social relationships in urbanized societies.

Appendix A. Quality assessment of included studies

Study	Methodological Quality Criteria																				Quality Score	Quality Rating
	1. Qualitative					3. Quantitative non-randomized					4. Quantitative descriptive					5. Mixed methods						
	1.1	1.2.	1.3.	1.4.	1.5.	3.1.	3.2.	3.3.	3.4.	3.5.	4.1.	4.2.	4.3.	4.4.	4.5.	5.1.	5.2.	5.3.	5.4.	5.5.		
Astell-Burt et al. (2015)											+	+	+	CT	−						3	MQ
Cattell et al. (2008)	+	+	−	+	+																4	MQ
Cohen et al. (2008)											+	+	+	+	+						5	HQ
Coley et al. (1997)	+	−	+	+	+																4	MQ
Cox et al. (2017)											+	−	+	CT	+						3	MQ
Cox et al. (2018)											−	−	+	CT	+						2	LQ
Dadvand et al. (2016)											+	CT	+	+	+						4	MQ
de Vries et al. (2013)																−	+	+	+	−	3	MQ
Dinnie et al. (2013)	+	+	+	+	+																5	HQ
Dzhambov et al. (2018)											+	−	+	+	+						4	MQ
Fan et al. (2011)											+	+	+	−	+						4	MQ
Gobster (1998)	+	+	−	−	+																3	MQ
Gómez et al. (2015)											−	−	+	−	+						2	LQ
Hale et al. (2011)	+	+	+	−	+																4	MQ
Harris et al. (2014)	+	+	+	+	+																5	HQ
Holtan et al. (2015)											+	+	+	CT	+						4	MQ
A. Hong et al. (2018)											+	−	+	CT	+						3	MQ
Hordyk et al. (2015)	+	+	+	+	+																5	HQ
Huang et al. (2006)	+	+	+	+	+																5	HQ
Jibril & Elfartas (2018)											−	−	+	CT	+						2	LQ
Kaźmierczak (2013)																−	+	+	+	+	4	MQ
Kemperman & Timmermans (2014)											+	−	+	CT	+						3	MQ
Kingsley & Townsend (2006)	+	+	+	+	+																5	HQ
Korn et al. (2018)						−	+	+	+	+											4	MQ
Krellenberg et al. (2014)																−	+	+	+	−	3	MQ

Note. + = "Yes"; − = "No"; CT = "Can't tell". HQ = High quality; MQ = Medium quality; LQ = Low quality. No included studies use quantitative randomized controlled trials research method; thus, corresponding criteria 2.1.-2.5. were omitted in the table.

Appendix A. Quality assessment of included studies (continued)

Study	Methodological Quality Criteria																				Quality Score	Quality Rating
	1. Qualitative					3. Quantitative non-randomized					4. Quantitative descriptive					5. Mixed methods						
	1.1	1.2.	1.3.	1.4.	1.5.	3.1.	3.2.	3.3.	3.4.	3.5.	4.1.	4.2.	4.3.	4.4.	4.5.	5.1.	5.2.	5.3.	5.4.	5.5.		
Kuo et al. (1998)											−	−	+	+	+						3	MQ
Kweon et al. (1998)											+	−	+	CT	+						3	MQ
Maas et al. (2009)											+	+	+	CT	+						4	MQ
Mangadu et al. (2016)																−	+	+	CT	+	3	MQ
Moulay et al. (2017)																−	+	−	+	+	3	MQ
Mowen & Rung (2016)											−	CT	+	CT	+						2	LQ
Noone et al. (2017)	+	+	+	+	+																5	HQ
O'Brien et al. (2010)	+	−	+	−	+																3	MQ
Orban et al. (2017)											+	+	+	CT	+						4	MQ
Peters (2010)	+	+	−	+	+																4	MQ
Peters et al. (2010)																+	+	+	+	+	5	HQ
Pleson et al. (2014)	+	+	+	+	+																5	HQ
Ruijsbrock et al. (2017)											+	+	+	CT	+						4	MQ
Seeland et al. (2009)											−	−	+	+	+						3	MQ
Shanahan et al. (2016)											+	+	+	CT	+						4	MQ
Soga et al. (2017)						+	+	+	+	+											5	HQ
Sugiyama et al. (2008)											+	CT	+	+	+						4	MQ
Sullivan et al. (2004)	+	+	+	+	+																5	HQ
Teig et al. (2009)	+	+	+	+	+																5	HQ
Triguero-Mas et al. (2015)											+	CT	+	+	+						4	MQ
Ulmer et al. (2016)											+	+	+	CT	+						4	MQ
van den Berg et al. (2010)						+	+	+	+	−											4	MQ
Veen et al. (2015)																−	+	+	+	−	3	MQ
Whatley et al. (2015)	+	+	+	−	+																4	MQ
Zhang et al. (2018)											+	+	+	CT	+						4	MQ
Zijlema et al. (2017)											+	+	+	CT	+						4	MQ

Note. + = "Yes"; − = "No"; CT = "Can't tell". HQ = High quality; MQ = Medium quality; LQ = Low quality. No included studies use quantitative randomized controlled trials research method; thus, corresponding criteria 2.1.-2.5. were omitted in the table.

Appendix B. Mixed methods appraisal tool: assessment criteria (adopted from Hong, Pluye, et al., 2018)

1. Qualitative	1.1. Is the qualitative approach appropriate to answer the research question? 1.2. Are the qualitative data collection methods adequate to address the research question? 1.3. Are the findings adequately derived from the data? 1.4. Is the interpretation of results sufficiently substantiated by data? 1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?
2. Quantitative randomized controlled trials	2.1. Is randomization appropriately performed? 2.2. Are the groups comparable at baseline? 2.3. Are there complete outcome data? 2.4. Are outcome assessors blinded to the intervention provided? 2.5 Did the participants adhere to the assigned intervention?
3. Quantitative non-randomized	3.1. Are the participants representative of the target population? 3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)? 3.3. Are there complete outcome data? 3.4. Are the confounders accounted for in the design and analysis? 3.5. During the study period, is the intervention administered (or exposure occurred) as intended?
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the research question? 4.2. Is the sample representative of the target population? 4.3. Are the measurements appropriate? 4.4. Is the risk of nonresponse bias low? 4.5. Is the statistical analysis appropriate to answer the research question?
5. Mixed methods	5.1. Is there an adequate rationale for using a mixed methods design to address the research question? 5.2. Are the different components of the study effectively integrated to answer the research question? 5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted? 5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? 5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?

Appendix C. Identified green spaces' aspects that promote social cohesion

Study	Physical characteristics						
	Presence of vegetation	Distance	Size	Types of green space	Layout & structure	Facilities	Maintenance
Astell-Burt et al. (2015)		×					
Cattell et al. (2008)						×	
Cohen et al. (2008)	×						
Coley et al. (1997)	×	×					
Cox et al. (2017)							
Cox et al. (2018)							
Dadvand et al. (2016)	×	×					
de Vries et al. (2013)	×						
Dinnie et al. (2013)					×		
Dzhambov et al. (2018)		×					
Fan et al. (2011)	×	×	×				
Gobster (1998)						×	
Gómez et al. (2015)							
Hale et al. (2011)						×	
Harris et al. (2014)							
Holtan et al. (2015)	×			×			
A. Hong et al. (2018)							
Hordyk et al. (2015)	×						
Huang et al. (2006)						×	
Jibril & Elfartas (2018)	×						
Kaźmierczak (2013)						×	×
Kemperman & Timmermans (2014)							×
Kingsley & Townsend (2006)				×	×	×	
Korn et al. (2018)							
Krellenberg et al. (2014)							×
Kuo et al. (1998)	×						
Kweon et al. (1998)	×						
Mangadu et al. (2016)						×	
Maas et al. (2009)	×						
Moulay et al. (2017)					×		
Mowen & Rung (2016)							
Noone et al. (2017)						×	
O'Brien et al. (2010)							
Orban et al. (2017)	×						
Peters (2010)		×	×				
Peters et al. (2010)			×				
Pleson et al. (2014)							
Ruijsbrock et al. (2017)	×						
Seeland et al. (2009)							
Shanahan et al. (2016)							
Soga et al. (2017)							
Sugiyama et al. (2008)							
Sullivan et al. (2004)	×						
Teig et al. (2009)				×			
Triguero-Mas et al. (2015)	×						
Ulmer et al. (2016)	×						
van den Berg et al. (2010)				×			
Veen et al. (2016)							
Whatley et al. (2015)				×			
Zhang et al. (2018)	×						
Zijlema et al. (2017)		×					

Note. × = indicating identified factors appeared in sampled studies.

Appendix C. Identified green spaces' aspects that promote social cohesion (continued)

Study	Perceptions of the environment			Use patterns			
	Perceived greenness	Perceived proximity	Perceived safety	Frequency	Duration	Activities	Public participation
Astell-Burt et al. (2015)							
Cattell et al. (2008)				×			
Cohen et al. (2008)							
Coley et al. (1997)				×			
Cox et al. (2017)				×	×		
Cox et al. (2018)				×	×		
Dadvand et al. (2016)		×					
de Vries et al. (2013)	×						
Dinnie et al. (2013)			×		×	×	
Dzhambov et al. (2018)	×						
Fan et al. (2011)							
Gobster (1998)							
Gómez et al. (2015)		×		×			
Hale et al. (2011)							
Harris et al. (2014)						×	
Holtan et al. (2015)							
A. Hong et al. (2018)	×		×				
Hordyk et al. (2015)						×	
Huang et al. (2006)						×	
Jibril & Elfartas (2018)			×				
Kaźmierczak (2013)			×	×	×	×	
Kemperman & Timmermans (2014)	×						
Kingsley & Townsend (2006)			×		×		
Korn et al. (2018)							×
Krellenberg et al. (2014)							
Kuo et al. (1998)				×			
Kweon et al. (1998)					×		
Mangadu et al. (2016)							
Maas et al. (2009)							
Moulay et al. (2017)							
Mowen & Rung (2016)				×	×	×	
Noone et al. (2017)							
O'Brien et al. (2010)						×	
Orban et al. (2017)							
Peters (2010)						×	
Peters et al. (2010)						×	×
Pleson et al. (2014)						×	
Ruijsbrock et al. (2017)	×						
Seeland et al. (2009)		×					
Shanahan et al. (2016)				×	×		
Soga et al. (2017)				×	×		
Sugiyama et al. (2008)	×						
Sullivan et al. (2004)							
Teig et al. (2009)						×	×
Triguero-Mas et al. (2015)							
Ulmer et al. (2016)							
van den Berg et al. (2010)							
Veen et al. (2016)							×
Whatley et al. (2015)							
Zhang et al. (2018)							
Zijlema et al. (2017)				×			

Note. × = indicating identified factors appeared in sampled studies

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