Research article

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Perceived Safety and Urban Green Space Attendance: A Narrative Review

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Tania Noël[1,*], Nancy Durieux[2], & Benoit Dardenne[3]

1 University of Liège, Belgium, tania.noel@uliege.be, https://orcid.org/0000-0003-2417-9909

2 University of Liège, Belgium, nancy.durieux@uliege.be, https://orcid.org/0000-0002-4688-293X

3 University of Liège, Belgium, b.dardenne@uliege.be, https://orcid.org/0000-0002-4001-7101

* Address for correspondence: tania.noel@uliege.be,
Faculty of Psychology, University of Liege, Quartier Agora – Place des Orateurs 2, 4000 Liège 1, Belgium.

Author statement

TN: Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Writing – original draft. ND: Methodology, Writing – review & editing. BD: Conceptualization, Funding acquisition, Writing – review & editing

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Abstract

With growing evidence linking Urban Green Spaces (UGS) exposure to health benefits, understanding their use and under-use has become increasingly important. Safety perception is frequently cited as a major factor influencing UGS attendance; however, this relationship is complex and remains a subject of debate, warranting further investigation. To explore this relationship, we conducted a narrative review examining how studies in this area have been conducted and their main findings. Using PsycINFO (Ovid) and Sociological Abstracts (ProQuest), we included 18 studies published between 2006 and 2022. This review provides a snapshot of the current state of research, revealing that the impact of safety perception on UGS attendance is more nuanced than it might initially appear. The complexity of this relationship, combined with significant challenges and gaps in UGS perception research - such as imprecise and inconsistent conceptualization and measurement of key variables - precludes drawing generalized conclusions. Consequently, broad, one-size-fits-all interventions targeting safety concerns are not to be recommended. Instead, these findings highlight the need for tailored, context-sensitive solutions that account for the specific factors shaping UGS use across different settings. High-quality research is still required to uncover the underlying mechanisms driving these relationships.

Keywords

Urban green spaces, perceived safety, public space attendance, narrative review.

Impact statement

We reviewed 18 studies on the relationship between safety perception and the use of urban green spaces (UGS), showing that this relationship is complex, context-dependent, and not yet fully understood. Safety-focused interventions in UGS can sometimes conflict with other management goals, such as preserving restorative qualities. For instance, sound-absorbing vegetation supports natural soundscapes and restoration, but can obstruct sightlines and reduce perceived safety. Given often limited management resources, and the fact that many users - particularly in neighborhood parks - feel a sense of familiarity that could buffer against feelings of insecurity, interventions addressing safety should be carefully prioritized and adapted to local contexts. Rather than questioning the role of safety perception, this review underscores the need to better understand the underlying mechanisms through further controlled experimental research, while also highlighting the need for high-quality on-site studies as a foundation for effective, context-sensitive UGS management, an area where applied environmental psychology has clear relevance.

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1 Introduction

Over half of the global population lives in urban areas (Ritchie et al., 2024), where access to nature is largely limited to semi-natural spaces such as parks, playgrounds, and yards, collectively referred to as Urban Green Spaces (UGS). Considering the growing evidence of a positive relationship between exposure to UGS and human well-being, and the significant ecosystem services provided even by small-scale spaces like "pocket parks" (Przewoźna et al., 2024), it is essential to advance understanding of both their use and under-use (Noël et al., 2021). Safety perception has often been considered as playing a major role in UGS attendance, especially in high-poverty neighborhoods (Cohen et al., 2010, 2016; Han et al., 2018; Thompson et al., 2010). However, the relationship between safety perception of UGS' by users and non-users and UGS' attendance is complex and far from being unanimously accepted (Han et al., 2018; Lapham et al., 2016), highlighting the need for further investigation.

Reviewing this literature requires a clear understanding of the core concepts. Regarding green spaces, the term often lacks a clear definition. This lack of standardization has been explicitly acknowledged, for example, by the World Health Organization (WHO), which noted that no universally accepted definition of UGS currently exists (WHO, 2016). In its reports, the WHO adopts a broad definition encompassing any urban space covered by vegetation of any kind, regardless of size, function, or ownership, while emphasizing the importance of publicly accessible spaces for equity considerations (WHO, 2016, 2017).

This definitional breadth is reflected in academic literature. For example, Taylor and Hochuli (2017) showed that the term *greenspace* is used in at least two distinct ways: in some studies as a broad synonym for nature, and in others to refer more narrowly to urban vegetation or urban green spaces. The latter, "urban greenspace," is especially relevant given rising urbanization rates worldwide (Ritchie et al., 2024) but is subject to the same observations of inconsistency in terms of definition as the overarching concept of green spaces. In their recent review, Clarke et al. (2023) found that over 30% of studies did not specify the type of greenspace analyzed, and for those that did, the definitions ranged widely, covering spaces from urban parks and forests to community and school gardens and even memorial sites. As awareness of the importance of UGS grows (e.g., Chen et al., 2025; Hu et al., 2025; Reyes-Riveros et al., 2021; Rojas-Rueda et al., 2019; Twohig-Bennett & Jones, 2018; Zhang et al., 2025), definitions and implementation practices still vary significantly, with the only consistent elements being their urban setting and the presence of vegetation.

What appears to be widely agreed upon, however, are the significant health benefits associated with UGS exposure (e.g., Chen et al., 2025; Hu et al., 2025; Reyes-Riveros et al., 2021; Rojas-Rueda et al., 2019; Twohig-Bennett & Jones, 2018; Zhang et al., 2025). To assess UGS exposure, studies often use indicators such as availability (e.g., percentage of UGS by area) or accessibility (e.g., proximity of UGS), which provide valuable insights into potential exposure (WHO, 2016), but fall short of capturing actual exposure. To assess real exposure, studies can include attendance measures, (e.g., visit frequency) (WHO, 2016). Attendance can be

tracked through objective counts (e.g., Cohen et al., 2013) or subjective self-reports (e.g., Costigan et al., 2017), and may focus on actual behavior (Cohen et al., 2009, 2010, 2013) or behavioral intention (Yen et al., 2017).

When it comes to the concept of safety, it encompasses various perspectives and interpretations. The WHO (1998) distinguishes between objective safety (i.e. measurable, external indicators of safety), and subjective safety, also referred to as perceived safety (i.e. an individual's internal perception of safety). Perceived safety does not always align with objective safety (for instance, crime rates; Pérez-Tejera et al., 2022; Zhang et al., 2021) and is typically a stronger predictor of UGS visits and duration of stay than some objective measures (for instance crime statistics, see Cohen et al., 2019). It is equally important to distinguish perceived safety from the extensively studied concept of fear of crime (Hinkle, 2015), which focusses on crime-related emotions (Camacho Doyle et al., 2022; Etopio & Berthelot, 2022; Hinkle, 2015). Not only do some researchers argue that UGS safety concerns should extend beyond fear of crime to include other factor, such as fear of accidents (Türkseven Doğrusoy & Zengel, 2017) or fear of traffic (Krenichyn, 2006), but definitions of fear of crime also vary, often leading to inconsistent measurements (Collins, 2016; Etopio & Berthelot, 2022). Studies often report measuring fear of crime when they are actually measuring perceived safety (Yang & Hinkle, 2012). According to some authors, perceived safety is measured through more standardized questions (Hinkle, 2015), and should make perceived safety more suitable for comparative studies and systematic reviews.

Safety perception has often been considered as playing a major role in UGS attendance (e.g., Cohen et al., 2010, 2016; Han et al., 2018; Thompson et al., 2010). However, this relationship remains far from being unanimously accepted (Han et al., 2018; Lapham et al., 2016), warranting further investigation. . A narrative review is particularly well suited to synthesizing research that draws on diverse theoretical frameworks and methodological approaches and enables an in-depth examination of the literature (Baumeister, 2013; Greenhalgh et al., 2018). Accordingly, this narrative review aims to explore this relationship by addressing the following questions and sub-questions:

1. How have studies investigating this relationship been conducted?
    a. How do studies define (i.e., conceptual descriptions) and characterize (i.e., specific attributes) UGS?
    b. What indicators are used to evaluate UGS' attendance?
    c. What indicators are used to assess UGS' perceived safety?
    d. How is this relationship measured (i.e., methodologies or metrics)?

2. What are the main findings of these studies regarding the safety perception and attendance relationship?

2 Methods

To be included in this review, studies had to examine the relationship between UGS attendance and perceived safety, with UGS considered in the present review

as any outdoor/open-air space (public or private), accessible to the public without fees or other entry restrictions, located in urban areas, and containing vegetation of any kind. Only studies explicitly stating that they did not meet one or more of these criteria were excluded. This extended inclusion criterion regarding UGS was intentionally considered due to the lack of consistency in existing definitions. Any measurement of UGS attendance and any subjective assessment of the safety conditions of a UGS, ranging beyond the measurement of one or more specific crimes, were considered. Eligible studies included participants of any demographic background, whether or not they used UGS, and imposed no restrictions on geographic location. Studies reporting quantitative, qualitative, or mixed-method data were considered. All types of review, text, and opinion papers were excluded to ensure a focus on peer-reviewed primary research. Studies published in English, German, or French were considered, and no restrictions were applied with respect to the year of publication. A comprehensive list of all inclusion and exclusion criteria is provided on OSF.

PsycINFO (Ovid) and Sociological abstracts (ProQuest) were searched in November 2024. The search strategy was adapted for each database (search strategies are available on OSF), incorporating relevant keywords and index terms. In addition, reference lists of all included articles were hand-searched for additional sources, and the search was complemented by the authors' knowledge of the field, including the identification of relevant articles not captured by the database searches.

Following the search, all identified citations were uploaded into Covidence (Veritas Health Innovation, Melbourne, Australia) and duplicates automatically removed. Any other duplicates were manually removed throughout the selection process. All stages of the review process (Fig.1) were conducted by a single reviewer (the first author of this paper), including title and abstract screening, full-text assessment, data extraction, and synthesis of findings.

3 Results

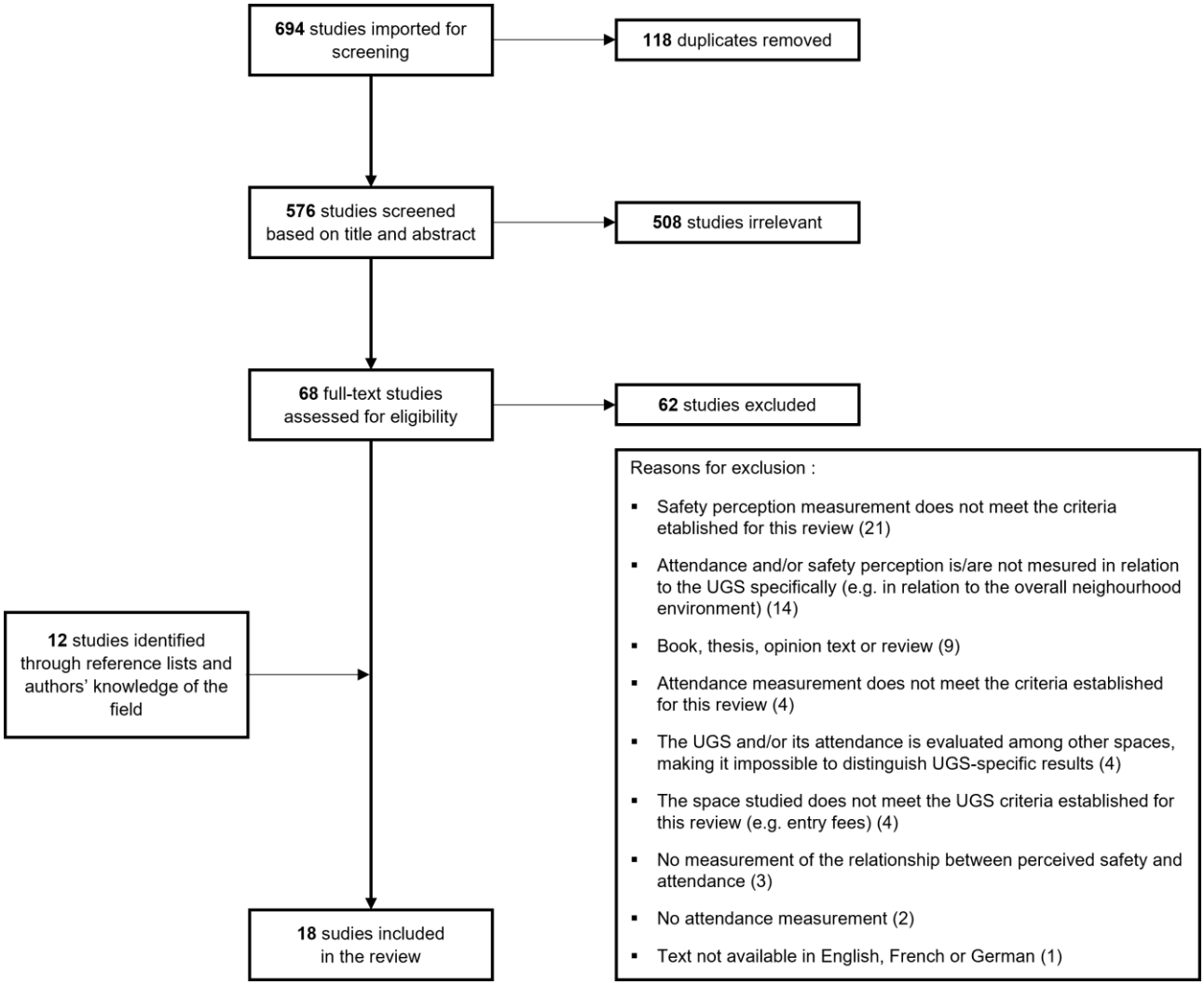
3.1 Study selection

A total of 694 records were retrieved through database searching. Of these 694 records, 118 duplicates were removed, and 508 were excluded through title and abstract screening. Full texts of the remaining 68 studies were assessed for eligibility. In total, 62 studies were excluded from the review, with reasons for exclusion at the full-text stage summarized in the Flowchart (Fig. 1). A complete list of studies excluded at the full-text screening stage, together with their corresponding reasons for exclusion, is available on OSF. The final set of 18 studies included in this review comprised both studies identified through database searching and additional studies identified through reference list screening of included articles, complemented by the authors' knowledge of the field.

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Figure 1.

Flowchart.



Note. Only the first exclusion reason identified during screening was reported for each article.

3.2 Characteristics of included studies

The 18 studies included in this review were published between 2006 and 2022. The studies were conducted across diverse geographical contexts, with a strong predominance of research carried out in the United States (n = 13). A smaller number of studies were conducted in other regions, including Asia (n = 3), Australia (n = 1), and Africa (n = 1), while no studies conducted in Europe or South America were identified.

The relationship between UGS attendance and perceived safety was most often examined quantitatively (n = 13), while fewer studies examined this relationship qualitatively (n = 5). Nearly half of the studies (n = 8) were conducted by the same research team.

An overview of the main characteristics and findings of the included studies are reported in Table 1.

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Table 1

Key characteristics and main findings of included studies

	Study	Objective	Participants	Location	UGS definition and characteristics	Perceived safety measurement method	Attendance measurement method	Relationship between perceived safety and attendance
1	Krenichyn (2006)	Explores women's physical activity (PA) in a specific UGS in Brooklyn.	UGS users N = 41	US (NY)	No definition. Detailed characteristics: facilities/programs; size; neighborhood; landscape/architecture; visit rate.	Open questions (e.g., concerns or difficulties in using the UGS)	Self-reported - Open questions (e.g., patterns of PA in the UGS)	Qualitative. Participants often addressed safety aspects (e.g., physical safety regarding traffic, harassment).
2	Cohen et al. (2009)	Assesses the impact of UGS improvements on use and PA.	UGS users/ non-users N = 2867	US (CA)	No definition. Detailed characteristics: facilities/programs; size; neighborhood.	No information.	Observation (SOPARC) + Self-reported - Interviews with ordinal answer options (never / only once / <1 per month / >1 per month / >1 per week / daily) – No more information.	Quantitative. Perceived safety was not associated with observed attendance measures or self-reported attendance measures (significance cannot be addressed, since statistics are not provided).
3	Loukaitou-Sideris and Sideris (2009)	Examines factors influencing children's UGS visitation and patterns across demographics.	Children, parents N = 1245	US (CA)	No definition. Detailed characteristics: facilities/programs.	One single question – "Do you feel safe at the park?" (yes/no)	Observation (SOPLAY) - not used in relation to perceived safety + Self-reported – children and parents: •) "Do you [does your child] participate in physically active organized activities in the park?" (yes/no) •) "Where do you [does your child] spend most time playing sports and being physically active?" (school/park/backyard/neighborhood street/other)	Qualitative. Participants often addressed safety aspects (e.g., choosing one UGS rather than another based on safety perception, concerns about crime and traffic).
4	Cohen et al. (2010)	Assesses how UGS characteristics and demographics relate to UGS use.	UGS users/ non-users N = 4300	US (CA)	No definition. Detailed characteristics: facilities/programs; size; neighborhood.	One single question - "In general, how safe do you feel this park is?" (very safe/safe/not very safe/not safe at all).	Observation (SOPARC) + Self-reported - "How often do you come to this park?" (not used in relation to perceived safety).	Quantitative. Perceived safety was not significantly associated with observed UGS use.

	Study	Objective	Participants	Location	UGS definition and characteristics	Perceived safety measurement method	Attendance measurement method	Relationship between perceived safety and attendance
5	Willemse and Donaldson (2012)	Explores UGS usage patterns and opinions in Cape Town townships.	Children, parents N = 324	Africa (Cape Town)	"*Developable land with recreation facilities, which serve the needs of the local community or neighborhood and are usually accessed on foot. It includes informal recreation facilities of small scale for children such as totlots and playgrounds, seating areas, open grass lawns and gardens.*" UGS characteristics: not provided.	Open- and closed-ended questions – No more information.	Self-reported - Open- and closed-ended questions - No more information.	Qualitative (percentage). Safety concerns was the most frequently cited main reason for non-use of UGS.
6	Cohen et al. (2012)	Conceptualizes factors affecting UGS use and PA in relation to neighborhood poverty.	UGS users/ non-users N = 6903	US (CA)	No definition. Detailed characteristics: facilities/programs; safety aspects.	One single question - Feeling the park is safe/unsafe - No more information.	Observation (SOPARC) - not used in relation to perceived safety. + Self-reported – No more information.	Quantitative. Perceived safety was not significantly associated with frequency of visiting the UGS among users but was significantly associated with frequency of visiting the UGS among locals. Perceived safety was not significantly associated with exercise sessions for either group.
7	Cohen et al. (2013)	Determines whether neighborhood socioeconomic status affects UGS use and PA.	UGS users/ non-users N = 7374	US (PA, OH, NC, NM)	No definition. Detailed characteristics: facilities/programs; neighborhood.	Perceiving the park to be very safe/safe/unsafe - No more information.	Observation (SOPARC). + Self-reported - Frequency of UGS use over the last 7 days; Usual exercise (%); Meet people (%) (not used in relation to perceived safety).	Quantitative. Perceived safety was not significantly associated with the number of observed UGS users.
8	Cohen et al. (2015)	Explores the impact of UGS renovation on youth PA.	UGS users/ non-users N = 1965	US (CA)	No definition. Detailed characteristics: facilities/programs; size; neighborhood.	No information.	Observation (SOPARC) - not used in relation to perceived safety. + Self-reported - Interviews – No more information.	Quantitative. Perceived safety was significantly associated with the number of UGS visits among users and residents. Perceived safety was also significantly associated with exercise sessions among residents, but not among users.

	Study	Objective	Participants	Location	UGS definition and characteristics	Perceived safety measurement method	Attendance measurement method	Relationship between perceived safety and attendance
9	Lapham et al. (2016)	Investigates how perceived safety and UGS characteristics influence visitation and activities.	UGS users/ non-users N = 3815	US (PA, OH, NC, NM)	No definition. UGS characteristics: size.	Perceiving the park to be very safe/safe, not very safe/not safe at all – No more information.	Self-reported - "How often do you come to this park?" (responses consisted of 'daily' to 'never') – No more information.	Quantitative. Perceived safety was significantly associated with reporting having ever visited the UGS.
10	Cohen et al. (2017)	Tests whether additional programming, incentives, or both increase UGS use in high-poverty areas.	UGS users/ non-users N = 6189	US (CA)	No definition. UGS characteristics: accessibility; facilities/programs.	Perceiving the park to be very safe/safe, not very safe/not safe at all – No more information.	Observation (SOPARC) - not used in relation to perceived safety. + Self-reported – Interviews – No more information.	Quantitative. Perceived safety/unsafety was significantly associated with the number of UGS visits in the last 7 days. Perceived safety, but not unsafety, was significantly associated with duration of stay.
11	Costigan et al. (2017)	Examines the importance of UGS features for PA by sex, age, and parental status.	UGS users/ non-users (Families) N = 2775	Australia (Melbourne)	No definition. Detailed characteristics: facilities/programs; size; neighborhood.	Ranking of the importance of 20 UGS features (e.g. well maintained, feel safe going there, relaxing, easy to get to, shade trees) for encouraging UGS-based PA in the next fortnight. Responses were dichotomized as 'not important' versus 'important'	Self-reported. •) "Have you visited a park in the past 7 days?" (yes/no) •) "In the past 3 months, on average, how often have you visited a park?" (1 = daily; 2 = 2–3 times per week; 3 = once per week; 4 = 2–3 times per month; 5 = once per month; 6 = <once per month; 7 = first time to this park). Responses were dichotomized ('At least once per week' versus 'less than once per week')	Quantitative (rankings). Feeling safe was the second most important feature (after "well maintained") stated by participants for UGS-based PA.
12	Yen et al. (2017)	Investigates young residents' behavioral intentions to use UGS in Phnom Penh, using the Theory of Planned Behavior.	UGS users/ non-users N = 554	Asia (Cambodia)	No definition. UGS characteristics: not provided.	4 items, 5-point Likert scale, from 1 (strongly concern) to 5 (no concern at all). •) Accidents •) Robbery •) Violence •) Personal safety (Total score)	Self-reported - Behavioral intention to visit the UGS, 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). •) I intend to visit UGSs if they are near my home •) I will visit UGSs if they are safe •) I will visit UGSs more often if there are facilities and green areas (e.g., flowers and trees) •) I intend to visit UGSs more often in the future	Quantitative. Perceived safety was significantly associated with the behavioral intention to use UGS.

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	Study	Objective	Participants	Location	UGS definition and characteristics	Perceived safety measurement method	Attendance measurement method	Relationship between perceived safety and attendance
13	Türkseven Dogrusoy and Zengel (2017)	Examines relationships between perceived safety, broader safety factors, and UGS use.	UGS users N = 442	Asia (Turkey)	No definition. Detailed characteristics: neighborhood; landscape/architecture.	13 items, 5-point Likert scale (completely agree / completely disagree). •) I am annoyed by the fact that unsafe people are wondering around •) It is possible to experience sexual harassment in this park •) Some disturbing circumstances can happen in this park •) Robbery and theft are unusual in this park •) I can visit this park during the night without any hesitation •) I feel safer when the park is crowded •) I recommend this park to others •) I enjoy being here •) I feel safe in this park •) I am nervous about the fact that trees obstruct my view in some places of the park •) I can find my way easily in this park •) Some hiding places disturb me in this park	Self-reported - Close-ended questions. (e.g. participants were asked how frequently they visit the target UGS).	Quantitative. Perceived safety was significantly associated with visit frequency and duration of stay in unsafe UGS, whereas no such associations were observed for UGS classified as safe.
14	Derose et al. (2018)	Explores gender differences in UGS use and PA.	UGS users/ non-users N = 2973	US (CA)	No definition. Detailed characteristics: facilities/programs; size; neighborhood; visit rate.	Perceiving the park to be safe or very safe vs. not very safe or not at all safe /safe, not very safe/not safe at all – No more information.	Self-reported – number of visits to parks in the last 7 days and typical duration of park visit (min)	Quantitative. Perceiving the park as safe was consistently and positively associated with park use (number of visits and duration of stay).
15	Aliyas and Nezhad (2019)	Identifies factors influencing the use of historical Persian gardens (UGS).	UGS users N = 775	Asia (Iran)	Definition: "*Historical Persian Garden including water and plan of gardens, divided into sectors. Walls surround these gardens to protect them from sandstorms and extreme climates, as well as to increase the feeling of privacy*". Detailed characteristics: size.	One single question, 5-point Likert scale - "I feel safe to walk alone in the garden" (strongly disagree/strongly agree)	Self-reported - 'How often do you visit this garden?", 5-point Likert scale, from 1 (a couple of days in a week) to 5 (once in a year).	Quantitative. Perceived safety was significantly associated with UGS visitation.

	Study	Objective	Participants	Location	UGS definition and characteristics	Perceived safety measurement method	Attendance measurement method	Relationship between perceived safety and attendance
16	Sonti et al. (2020)	Explores differences in UGS use and motivations by site type and respondent gender.	UGS users N = 955	US (NY)	Natural areas: "*forests, meadows, and wetlands occurring in New York City parklands" Landscaped areas: "landscaped, manicured, or programmed parkland such as lawns, ballfields, playgrounds and plazas*". Detailed characteristics: facilities/programs; neighborhood.	Open questions (What are you doing in the park today? Why do you choose to come here? In this park, do you ever go into the woods / wetland / trail area? If yes, what do you do there? If no, why not? Are you involved in any groups that help take care of the environment?)	Self-reported - Open questions (What are you doing in the park today? Why do you choose to come here? In this park, do you ever go into the woods / wetland / trail area? If yes, what do you do there? If no, why not? Are you involved in any groups that help take care of the environment?)	Qualitative. Many interviewees (41%) said not to visit UGS natural areas (most common barrier was fear or concern for safety), from which many expressed a preference for landscaped areas due to safety, comfort, and ongoing activities.
17	Groshong et al. (2020)	Examines safety-related influences on park use and PA in Kansas City.	UGS users/ non-users N = 41	US (MO)	No definition. Detailed characteristics: facilities/programs; size.	Open questions (e.g., what could help/hinder to be more active in parks - safety was not an explicit focus).	Self-reported - Open questions (e.g. what could help/hinder to be more active in parks - safety was not an explicit focus).	Qualitative. Safety emerged prominently in the original analysis of themes. Adult discussions especially returned repeatedly to safety regardless of the questions posed by the moderator.
18	Zhou et al., (2022)	Investigates how perceived safety and beauty affect time spent in parks.	UGS users/ non-users (big data)	US (IL)	No definition. UGS characteristics: not provided (street view images).	Google Street View images analyzed through machine learning models trained on crowd-sourced human ratings, assigning safety perception scores to the images. Scores range from 0 to 1, with a larger value referring to a safer perception.	Visits and dwelling times in parks through anonymized and aggregated GPS signals from mobile devices. Time spent in parks = average time spent in parks in minutes. Total visitation = total visitation of the park - not used in relation to perceived safety.	Quantitative. Perception of safety is statistically significantly associated with the increase of time spent in UGS.

3.3 Review findings

3.3.1 How have studies investigating this relationship been conducted?

Definition and characterization of UGS. Most studies did not provide an explicit definition of urban green spaces. Instead, UGS were generally characterized through descriptive attributes, such as available facilities, size and surroundings. These attributes varied substantially across studies and were often reported in a parsimonious manner, preventing a complete understanding of the spaces studied and leading study selection to be based primarily on described space characteristics. These characteristics varied widely depending on study objectives, further limiting comparability across studies. An exception is Zhou et al. (2022), whose image-based methodology provided comprehensive views of UGS in a single frame.

Indicators used to evaluate UGS' attendance. Regarding indicators used to asses UGS attendance, one study (Zhou et al., 2022) relied on aggregated GPS-based data to estimate visitation patterns and duration of use. Across studies, however, UGS attendance was primarily assessed using self-reported indicators, such as questions addressing visit frequency or time spent in UGS. Some studies complemented self-reports with observational methods, such as the System for Observing Play and Recreation in Communities (SOPARC) and the System for Observing Play and Leisure Activity in Youth (SOPLAY). SOPARC was the most used method. This method captures user data and physical activity (PA) through momentary time sampling, counting UGS users and assigning metabolic equivalent values (METs) to activities (e.g., sitting: 1.5 METs; walking: 3 METs; running: 5-6 METs) (McKenzie et al., 2006). SOPLAY, while similar, focuses on youth PA during play and leisure opportunities (McKenzie et al., 2000). Observational methods were always paired with self-reports and described in detail. Overall, attendance measures differed considerably in terms of operationalization and level of precision.

Indicators used to assess UGS' perceived safety. Perceived safety was most assessed using single-item self-report questions with ordinal response options (e.g., Likert-type scales). A smaller number of studies employed multi-item scales, open-ended questions, or alternative approaches, such as image-based assessments using Google Street View, analyzed by machine learning models trained on crowd-sourced ratings, producing aggregated, collective safety scores rather than individual-level data. Although Table 1 reports the general type of indicators used to measure perceived safety, many studies provided limited information on item wording, response scales, or psychometric properties.

Measurement of the relationship between attendance and perceived safety. None of the included studies provided evidence to support causal conclusions about the relationship between perceived safety and attendance. Even among the quantitative studies, which predominantly employed non-experimental designs (Aliyas & Masoudi Nezhad, 2019; Cohen et al., 2010, 2012, 2013; Costigan et al., 2017; Derose et al., 2018; Lapham et al., 2016; Türkseven Doğrusoy & Zengel,

2017; Yen et al., 2017; Zhou et al., 2022), only correlational inferences could be drawn. While Yen et al. (2017) suggested causal interpretations, their cross-sectional design only supports correlational findings. Experimental and quasi-experimental studies (Cohen et al., 2009, 2015, 2017) treated perceived safety and attendance as secondary, unmanipulated outcomes, also limiting causal inference. For example, Cohen et al. (2017) used a randomized pre-/post-intervention design testing PA programs in high-poverty neighborhoods, but attendance and safety perceptions were not manipulated variables. Similarly, quasi-experimental studies by Cohen et al., (2009, 2015) compared improved and control UGS using pre-/post-designs without randomization, with attendance and perceived safety as outcomes, thus still excluding causal conclusions.

3.3.2 What are the main findings regarding the relationship between attendance and perceived safety?

Overall, findings regarding the relationship between perceived safety and UGS attendance were heterogeneous and empirical results varied depending on study design, measurement approach, and population.

Across the qualitative studies, findings consistently indicated that perceived safety was a central factor shaping how different groups experienced and navigated UGS, rather than a secondary consideration. Willemse and Donaldson (2012) found safety concerns to be the most spontaneously cited reason for avoiding UGS, with desired improvements focusing on safety measures like safer play equipment, security guards, and cameras. Loukaitou-Sideris and Sideris (2009) similarly reported safety as a significant concern for children, but also for parents with over three-quarters of parents preventing unaccompanied visits due to fears of crime and traffic. Krenichyn (2006), highlighted safety as a key concern for women, noting that some valued the solitude of hidden areas, while others feared accidents or harassment. Sonti et al. (2020) noted that 41% of respondents avoided natural areas like forests and wetlands, favoring landscaped spaces due to fears of crime, animals (e.g., rats), or getting lost. Groshong et al. (2020) emphasized safety concerns as a critical factor influencing UGS use and PA in low-income, high-minority neighborhoods. Focus groups highlighted key facilitators, such as social interactions and adequate lighting, alongside major barriers, including violence, poor maintenance, and traffic hazards. Originally part of a broader study, the prominence of safety concerns prompted a reanalysis focused on this theme, underscoring its importance.

Complementing these qualitative insights, Costigan et al. (2017) used a large-scale quantitative survey to assess the perceived importance of park features for encouraging future UGS-based PA. While not statistically testing the relationship between perceived safety and UGS attendance, the study showed that feeling safe was consistently ranked among the most important UGS feature across participants.

Quantitative studies using non-experimental approaches showed mixed findings. Several studies identified significant associations between perceived safety and UGS attendance (Aliyas & Masoudi Nezhad, 2019; Derose et al., 2018; Lapham et al., 2016; Zhou et al., 2022; Yen et al., 2017), whereas others found no significant association (Cohen et al., 2010, 2013) or reported mixed results (Cohen et al.,

2012; Türkseven Doğrusoy & Zengel, 2017). Studies reporting no significant associations relied exclusively on observational attendance measures, whereas significant associations were primarily observed in studies using self-reported attendance measures, with the exception of Zhou et al. (2022). In this study, perceived safety scores derived from Google Street View images using machine learning models were combined with GPS-based attendance data.

Among studies with mixed results, Cohen et al. (2012) found a significant relationship between perceived safety and self-reported visit frequency among nearby residents, but not on-site UGS users. In the same study, exercise sessions were unrelated to safety perceptions for either group. Türkseven Doğrusoy and Zengel (2017), distinguishing between safe and unsafe UGS, found a significant association between safety perception and self-reported visit frequency and duration of stay in unsafe UGS, whereas no such associations were observed for UGS classified as safe.

In Yen et al. (2017), perceived safety is assessed by asking participants to rate concerns on a 5-point scale (1 = strongly concerned, 5 = no concern at all) and attendance intention on another 5-point scale (1 = strongly disagree [to attend the UGS], 5 = strongly agree [to attend the UGS]). Authors reported a negative impact of safety concerns on attendance intention. Given the direction of the safety scale, this association corresponds to higher attendance intention being associated with higher levels of concern.

Experimental and quasi-experimental studies by Cohen and colleagues (2009; 2015; 2017) reported mixed findings. Cohen et al. (2017) found that perceiving a UGS as safe was significantly associated with both visit frequency in the past 7 days and duration of stay. Perceiving a UGS as "not very safe" was also positively associated with visit frequency, but not with duration of stay. In Cohen et al. (2009), although specific statistics are not reported, changes in perceived safety following major improvements in the intervention UGS, as well as declines in perceived safety in control UGS, were not associated with either observed or self-reported attendance measures. Cohen et al. (2015) reported that perceived safety was significantly associated with self-reported visit frequency for both residents and on-site users, whereas an association with the number of exercise sessions was observed only among residents.

Taken together, qualitative studies consistently describe perceived safety as a central, rather than secondary, factor in UGS use. Across these studies, safety concerns are repeatedly reported as primary barriers to attendance and are frequently discussed alongside contextual features such as lighting, maintenance, social presence, and traffic conditions. In contrast, the quantitative literature does not reveal a clear or consistent pattern regarding the relationship between perceived safety and UGS attendance. Studies relying on direct observational measures of attendance consistently report non-significant associations, whereas findings based on self-reported attendance measures are heterogeneous and do not converge toward stable patterns across attendance indicators, population subgroups, or study contexts. A table summarizing all tested quantitative associations between perceived safety and UGS attendance was constructed and is provided as supplementary material on OSF.

4 Discussion

4.1 Characteristics of included studies

Although the literature on UGS is extensive, and issues related to safety are frequently discussed, far fewer studies explicitly examine the relationship between perceived safety and UGS attendance. The studies included in this review cover a limited time period, spanning from 2006 to 2022, and display several notable characteristics that should be considered when contextualizing the results.

First, the geographical distribution of studies is highly uneven. A strong predominance of studies conducted in the United States was observed, while only a small number of studies were carried out in Asia, Australia, and Africa, and none were conducted in Europe or South America. This imbalance suggests that findings of the present review are largely shaped by specific social, cultural, and urban contexts, which may limit the insight they can provide to other regions.

Second, with regard to methodological approaches, most studies examined the relationship between UGS attendance and perceived safety using quantitative analyses, whereas fewer studies relied on qualitative approaches. At the same time, the reliance on predominantly cross-sectional and observational designs means that the available evidence remains correlational in nature, thereby precluding causal conclusions regarding the relationship between perceived safety and UGS attendance. This quantitative emphasis may also limit insights into the contextual and experiential dimensions that qualitative approaches are better suited to capture.

Finally, nearly half of the included studies were conducted by the same research team, highlighting the influential role of a limited number of scholars in shaping this field of research. While this concentration may have contributed to theoretical and methodological coherence across studies, it also limits the diversity of perspectives and contexts represented in the literature. From a cumulative research perspective, broader engagement by independent research teams would be particularly valuable to support more comprehensive and robust reviews of the evidence.

4.2 How have studies investigating this relationship been conducted?

This discussion focuses on methodological and conceptual issues related to the definition and measurement methods, which may help explain the heterogeneity of findings reported across studies.

Most of the reviewed studies failed to define what was meant by the term UGS, which aligns with findings from previous research (Taylor & Hochuli, 2017). That said, based on the varied characteristics of UGS across studies, there is significant variability in how UGS are conceptualized. This inconsistency complicates comparisons, generalizations, and systematic reviews. The complexity is further compounded by the fact that UGS are studied in diverse disciplines, each employing specific methods, definitions, and measurement approaches. To address these challenges, operational definitions that are clear across sectors are essential for accurate characterization and quantification of UGS (Taylor & Hochuli, 2017). To

enhance comparability, it is advisable to focus on the most commonly studied UGS characteristics. Based on the studies included in this review, these include characteristics such as facilities, size, and neighborhood characteristics. Incorporating precise spatial coordinates and satellite visualization could offer additional information that might be missed in the original studies. Satellite imagery, combined with tools like Google Street View, offers a cost-effective, time-saving alternative to in-person perception-based research (Zhou et al., 2022). This approach enables large-scale data collection, allowing researchers to analyze a broader range of UGS rather than focusing on a limited selection, thereby enhancing the generalizability of findings.

Beyond how UGS are defined, substantial challenges also arise from how attendance is conceptualized and measured. Across studies, measurement methods differ substantially in their level of precision, temporal coverage, and analytical focus, limiting direct comparability across studies. Measurements also often lack clear definitions, raising questions about whether respondents interpret the term consistently. Passing through a UGS as a shortcut might qualify as "attendance" for some but not for others. Time spent in a UGS may also be a more meaningful indicator than the number of visits, as individuals may briefly pass through for convenience but avoid lingering due to safety concerns (e.g., fear of crime or deteriorated infrastructure, which may discourage activities due to fear of accidents). GPS-based data, as used by Zhou et al. (2022), captures visit frequency and duration but lacks the contextual understanding provided by direct observation. For instance, Türkseven Doğrusoy and Zengel (2017) found that safer, frequently visited UGS had shorter visit durations, while less safe parks saw longer stays, likely due to the types of activities performed (e.g., weekend picnics). These findings underscore the value of on-site research for interpreting results. In any case, the measurement method should align with the research objective. For studies where PA is key, tools like SOPARC (McKenzie et al., 2006), which systematically observe activities and calculate metabolic values, are useful. However, self-reported measures, depending on the phrasing, can provide insights into participants' motivations and cover a broader timeframe than direct observation, as they allow participants to report on past visit frequency. Precise question wording is crucial, as it shapes participants' interpretations and responses. Authors should also clarify with respondents what constitutes "attendance." An omnibus definition that defines attendance as any visit, regardless of reason, activity, or stay duration, could aid in comparison and has already been adopted by some authors (e.g., Schipperijn et al., 2010).

Regarding safety, the literature also raises both conceptual and measurement-related challenges that complicate cross-study comparison. In this review, we prioritized perceived safety over fear of crime for two main reasons. First, fear of crime addresses only a subset of safety concerns in public spaces; second, literature reveals inconsistencies its definition and measurement (Collins, 2016; Etopio & Berthelot, 2022). Given that the notion of perceived safety is broader and, according to some authors, measured through more standardized questions (Hinkle, 2015), we aimed for more comparable measures across studies. However, despite recurring question formats, the lack of universally accepted measures remains a limitation. Researchers should clearly define the concept they aim to explore and

align assessment methods accordingly (Hinkle, 2015). For example, asking how safe participants feel yields different responses than asking how afraid they are (Yang & Hinkle, 2012).

Qualitative insights further underscore the complexity of safety perception, highlighting a wide range of issues beyond fear of crime, and these concerns likely vary among individuals and regions (e.g., safety concerns in Europe may differ from those in Asia; Huai & Van de Voorde, 2022). From a measurement perspective, this complexity has direct implications for scale development. While multidimensional scales can capture broad safety constructs, developing a single measure that comprehensively reflects the diversity of safety concerns across contexts and populations remains challenging. Moreover, predetermined response items may bias participant responses (Yang & Hinkle, 2012). To address this, a single overarching measure—such as a semantic differential scale ranging from unsafe to safe—could be more effective if it aligns with a clearly defined safety concept. Pairing this with open-ended questions would allow participants to spontaneously identify specific safety concerns, potentially revealing overlooked factors. However, relying solely on open-ended responses risks missing important factors that are not immediately accessible to participants' minds. This could be addressed by later presenting a literature-derived list of safety concerns for evaluation using Likert scales. In response to these measurement challenges, recent studies have explored alternative, data-driven approaches to assessing perceived safety. Zhou et al. (2022) analyze safety perception scores from Google Street View images using machine learning trained on crowd-sourced ratings. Unlike traditional survey methods, which often focus on a limited number of UGS preselected by researchers, this approach enables the analysis of multiple UGS, reducing sampling bias and minimizing researchers' subjective preferences in park selection. This methodology has significant potential for advancing perception-based research, however, despite its apparent appeal, its use warrants careful consideration. While large-scale data collection and machine learning approaches are highly valuable from a fundamental research perspective and can substantially enhance the generalizability of findings, many UGS-related research and intervention efforts primarily aim to understand and address field-specific problems related to public health and social justice. Such objectives necessarily call for on-site research capable of capturing context-specific dynamics and may therefore rely more strongly on traditional survey and observational methods. Rather than being opposed, these approaches are both necessary and complementary and in the context of UGS research, environmental psychology but also other disciplines, would benefit from a continuous dialogue between fieldwork and controlled laboratory experimentation (Noël, 2023).

4.3 What are the main findings of these studies?

Building on these methodological considerations, we now turn to a more focused examination of the empirical evidence linking perceived safety and UGS attendance.

Examining the relationship between UGS safety perception and observed attendance reveals mixed findings. Three studies by the same team (Cohen et al., 2009, 2010, 2013) consistently reported no significant relationship between perceived

safety and observed attendance. While these results are notable for their consistency and the near-identical measurements of perceived safety and attendance across the studies, prior research by the team may have influenced the outcomes. Furthermore, the analyses seem to be conducted at the park level rather than the individual level, which fails to account for intra-individual variability and further limits the conclusions that can be drawn. By contrast, Zhou et al. (2022), using GPS-derived attendance data aggregated at a collective level, reported a significant positive association between perceived safety and UGS attendance. Although this approach also relies on observational data, it differs in spatial and temporal resolution from direct observational counts. Taken together, these findings suggest that null results observed in earlier observational studies may reflect methodological constraint, such as limited resolution or level of aggregation, rather than the absence of a relationship between perceived safety and UGS attendance.

Studies using self-reports showed more variability. Five studies found significant relationships between perceived safety and attendance (Aliyas & Masoudi Nezhad, 2019; Cohen et al., 2015, 2017; Derose et al., 2018; Lapham et al., 2016), while three reported inconsistent or unexpected results (Cohen et al., 2012; Türkseven Doğrusoy & Zengel, 2017; Yen et al., 2017). For instance, Cohen et al. (2012) observed a significant link between safety perceptions and number of visits among residents, but not among UGS users. Türkseven Doğrusoy and Zengel (2017) found that positive environmental factors properties regarding perceived safety (e.g., good lighting and maintenance) were associated with higher visit frequency and duration of stay, but this pattern was not mirrored with UGS with negative environmental properties (e.g. bad lighting and maintenance). Similarly, Cohen et al. (2017) noted that perceiving a UGS as both safe and "not very safe" was linked to visit frequency, but only perceiving it as safe was associated with longer stays. In Yen et al. (2017), the interpretation of findings is further complicated by the direction of the safety and attendance intention scales. Although the authors report a negative effect of safety concerns on attendance intention, the scale coding implies that higher intention is associated with higher levels of concern. Given the correlational design, the direction of this relationship cannot be determined, raising the possibility of measurement or coding issues.

The diversity of findings underscores the need to uncover the mechanisms driving these variations. Insights from fear of crime studies, excluded here, may help identify potential moderators and mediators, such as age (Barnett et al., 2017), gender, and past experiences (Sreetheran & van den Bosch, 2014). While future research would benefit from experimental or longitudinal designs, validated and transparent measures of safety and attendance, and data drawn from more diverse countries and contexts, the extent to which these gaps persist across broader literatures remains to be examined. Addressing these issues would nonetheless improve comparability and reliability and help generate more actionable insights for urban planning and public policy.

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4.4 Limitations

This review was conducted using a structured search strategy and a rigorous study selection process. However, only two databases were searched, and a single reviewer carried out all stages of the screening, acknowledging the possibility that some relevant studies may not have been identified. This narrative review did not aim to be exhaustive; instead, it examined a body of studies to understand how the relationship between perceived safety and the use of urban green spaces is conceptualised, measured and interpreted in the literature. Future reviews could enhance comprehensiveness by expanding the database search and incorporating studies on fear of crime or risk perception, which would provide valuable comparisons between these concepts and their related outcomes. Finally, due to the scope of the review and the substantial variation in study designs, the quality of the included studies was not systematically assessed. This absence should be taken into account when interpreting the findings, particularly given that several recurring methodological weaknesses were identified across the included studies. Nevertheless, the studies were subject to a critical examination, and methodological limitations and points of concern were explicitly reported in the review findings.

5 Conclusion

This review provides a snapshot of the current state of research, highlighting that the impact of safety perception on UGS attendance is more nuanced than it may appear. The complexity of this relationship, combined with key challenges and gaps in UGS perception research (e.g., inconsistent conceptualization, heterogeneous measurement methods, lack of causal designs, and geographic concentration of studies), precludes generalized solutions and underscores the need for tailored, context-sensitive interventions. High-quality research is essential to uncover underlying mechanisms, while effective on-the-ground interventions demand a deep understanding of context-specific factors.

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6 Open science statement



The search strategy for both databases, the detailed inclusion and exclusion criteria, the list of studies excluded at the full-text screening stage with corresponding reasons for exclusion, as well as an overview of the quantitative evidence extracted from the included studies are available on the OSF. We confirm that this review includes all identified studies that addressed our research question, and that no eligible study was intentionally excluded.

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