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Linking Outdoor Public Space Characteristics to Children's Perceived Safety in Urban Communities: An Environment–Behavior–Perception Framework

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Abstract

Outdoor public spaces in urban communities are essential for children's physical and mental well-being, as opportunities for free exploration, social interaction, and healthy development are closely related to how safe children perceive these environments to be. However, systematic frameworks for evaluating community outdoor public spaces and locally adapted instruments for assessing children's perceived safety remain limited, and the associations between spatial characteristics and perceived safety are not yet fully understood. This study integrates questionnaire survey data from residential communities in Wuhan, China. It develops an evaluation system for community outdoor public spaces based on naturalness, functionality, protection, and attractiveness, and constructs a measurement system for children's perceived safety covering motor vehicle traffic, walking and cycling, and social interaction environments. Within a physical environment–behavioral activity–psychological perception framework, multiple linear regression models and bootstrap analysis are used to examine associations between parent-reported assessments of community outdoor public spaces and children's self-reported perceived safety, as well as exploratory indirect associations involving outdoor activity. The results show that diversity of supporting facilities, age-appropriateness of movable toys, and terrain richness are positively associated with perceived safety, whereas parents' ratings of surveillance adequacy, age-appropriateness of fixed play equipment, accessibility to water and sand, diversity of natural materials, and suitability for all age groups are negatively associated with perceived safety. Outdoor activity duration shows exploratory indirect associations linking spatial appeal and the variety of public spaces with perceived safety. Based on these findings, the study proposes planning considerations for daily activity support, facility adaptability, and children's outdoor experiences, and extends research on child-friendly urban environments by providing context-specific evidence for improving community outdoor public spaces.

Keywords: child-friendly city; urban communities; outdoor public spaces; spatial characteristics; children's perceived safety; outdoor behavioral activities

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1. Introduction

Currently, nearly one-third of the global urban population consists of children. By 2050, it is projected that approximately 70% of children will live in urban areas [1]. Meanwhile,

high-density development and the expansion of motorized transportation increasingly encroach on children's play spaces, threatening their healthy development [2]. This trend highlights the growing need for Child-Friendly Cities. Early childhood-friendly city initiatives, based on the 1989 United Nations Convention on the Rights of the Child, emphasize universal protection of children's rights. Over time, these efforts have increasingly focused on optimizing public spaces and service facilities at the micro level, particularly within communities [3,4]. Communities, as the smallest functional and administrative units of urban space, are well-positioned to implement policies that address children's immediate needs [5]. The Child-Friendly Cities Initiative (CFCI), as emphasized in Shaping Urbanization for Children, should prioritize the community level. This approach both reduces service distances and optimizes outdoor space design, integrating children's needs into daily environments [1,6,7]. As a result, building child-friendly communities has become an increasingly prominent focus in recent years.

As a vital setting for children's play and social interaction, the community directly influences their physical health and cognitive development, playing a key role in fostering long-term social adaptability [8–10]. A child-friendly community is a model that safeguards children's rights at the neighborhood level through optimized physical environments, established social support networks, and diverse governance mechanisms. Its core features include accessible green spaces, safe transportation, inclusive social atmospheres, and opportunities for child participation. At its essence, it places children's needs at the center of community development [5,11]. Community outdoor public spaces, as primary venues for children's activities such as play, social interaction, and nature exploration, directly influence their independent mobility, physical and mental well-being, and social skills. As a result, these spaces have become an increasingly important focus in the development of child-friendly communities [12–14].

Despite the recognized importance of child-friendly outdoor public spaces, their development faces several practical challenges. First, dedicated children's facilities often lack adaptability. Planning and design have long been dominated by adult perspectives, with no unified community-scale framework or effective mechanisms for child participation. This disconnect produces spaces whose functions do not meet children's actual needs [3,12,15]. Second, significant gaps exist in security measures. Critical areas, such as maintenance of service facilities and environmental management, remain inadequate, while traffic risk prevention generally lags behind [16,17]. Furthermore, the natural environment and spatial appeal require urgent improvement, as the diversity of green spaces and availability of engaging landscapes remain limited, failing to satisfy children's curiosity and need for extended play [16,18,19]. These shortcomings reduce children's participation in outdoor public spaces and limit their ability to engage in outdoor activities independently. Research shows that when children feel sufficiently safe in these spaces, they are more willing to step out of the house and participate in group play [20]. This not only increases children's physical activity but also strengthens their sense of community belonging and social skills [11]. In other words, a child's sense of safety and freedom from risk in outdoor public spaces is essential for free exploration, active socialization, and healthy development [9,21]. Overall, enhancing children's perceived safety in outdoor public spaces is a key pathway for translating the concept of child-friendly communities into practice.

Accordingly, this study aims to examine associations between parent-reported assessments of community outdoor public spaces and children's self-reported perceived safety, explore potential pathways involving outdoor behavioral activities, and identify planning considerations for child-friendly communities. To support these aims, the study develops a conceptual framework for evaluating community outdoor public spaces and a measurement system for children's perceived safety across physical activity and social interaction

environments, providing the basis for the subsequent association and exploratory pathway analyses. These objectives guide the following research questions.

Research question 1 (RQ1): How are outdoor public space characteristics in urban communities associated with children's perceived safety?

Research question 2 (RQ2): Which specific characteristics of outdoor public spaces are more strongly associated with children's perceived safety, and how do these associations vary in direction and magnitude?

Research question 3 (RQ3): What exploratory indirect associations involving outdoor behavioral activities link parent-reported assessments of community outdoor public spaces to children's self-reported perceived safety?

2. Literature Review

2.1. Characteristics of Child-Friendly Outdoor Public Spaces in Urban Communities

As essential settings for children's development, community outdoor public spaces have attracted growing scholarly attention with increased recognition of children's needs. Early studies mainly focused on meeting children's basic safety and functional requirements during outdoor activities, while also acknowledging the complementary role of natural environments alongside artificial public spaces. Evidence indicates that measures such as traffic calming, well-connected sidewalks, walking school bus programs, and neighborhood watch initiatives can reduce physical environmental risks and ease children's concerns about unfamiliar threats [22,23]. Later research further emphasizes that natural elements, including varied topography and vegetation in small forests and woodlands, offer more engaging and multifunctional play opportunities. These natural environments can partly compensate for the limitations of artificial outdoor public spaces by supporting diverse forms of exploration and play [24,25]. As research has advanced, increasing attention has focused on the role of outdoor public spaces in supporting children's holistic development, including psychological well-being, risk assessment, and physical activity. Regarding psychological development, studies indicate that visually layered landscapes, vegetation, and well-integrated architectural elements stimulate children's curiosity and strengthen their sense of place attachment [19,26]. From a risk prevention perspective, outdoor spaces that incorporate sand, water features, and natural topography enable children to develop risk assessment skills through managed challenges [27]. In terms of physical activity support, facility diversity, accessibility, and adequate lighting reduce environmental barriers to children's participation in outdoor spaces and increase physical activity frequency. In addition, nearby activity spaces and continuous walking paths further enhance opportunities for spontaneous physical activity [28–30].

In recent years, research has increasingly shifted toward refined investigations across two key dimensions: children's psychological perception and social equity. From the perspective of psychological perception, spatial aesthetics and natural attributes provide a core foundation for fostering children's emotional attachment. Empirical studies indicate that the visual quality of community outdoor public spaces, higher proportions of green vegetation, accessible natural elements, and adequate maintenance have positive effects on children's overall mental health [31,32]. From a social equity perspective, research shows that children from economically disadvantaged families often face limited access to activity spaces and inadequate facilities. In contrast, more affluent families can offer broader activity opportunities, such as traveling to alternative locations or using private outdoor spaces. This inequality limits some children's participation in outdoor activities and opportunities for social interaction [33–35]. Community garden renovation and zero-waste site development initiatives that prioritize children and encourage broad family involvement can enhance the equity and inclusivity of outdoor public spaces while strengthening community

cohesion [16,36]. In addition, improving community spatial layouts by increasing access to green spaces and recreational facilities can further promote outdoor participation and social interaction among children from diverse socioeconomic backgrounds [37].

2.2. Children's Perceived Safety in Urban Communities

Perceived safety refers to an individual's psychological and emotional response to external environmental stimuli, encompassing both threat recognition and a sense of control [38]. Unlike objective safety, which is typically assessed using crime statistics and accident data, children's perceived safety emerges from their active interpretation of potential environmental risks. This interpretation is shaped by cognitive development, life experience, emotional state, and sociocultural background, and it subsequently generates corresponding emotional and psychological responses [39,40]. Children's safety perceptions are also strongly conditioned by cultural context. For example, Iranian children place greater emphasis on neighborhood friendliness and order around mosques, whereas European and American children tend to focus on school security and personal spatial control. By contrast, Chinese children emphasize the joint role of family and society in ensuring basic safety [39,41].

Children's sense of security plays a critical role in their ability to engage in independent activities. Persistent feelings of insecurity may lead to psychological difficulties, including anxiety and social withdrawal [42]. As a result, children's perceived safety largely determines whether they can freely explore their community environment and serves as a core indicator for assessing the effectiveness of child-friendly environment initiatives [28,39]. Early studies predominantly adopted an adult-centered perspective. In urban high-density environments, parental overprotection was particularly evident and contributed to reductions in both the frequency and duration of children's outdoor activities [22,43]. As research has progressed, scholars have increasingly identified systematic differences between children's own safety perceptions and parental judgments. Children tend to evaluate risk across more context-specific dimensions, placing greater emphasis on the controllability and familiarity of spaces. Parents, by contrast, focus more strongly on the presence of objective risk sources. Consequently, spaces that parents perceive as objectively risky, such as areas with natural vegetation or open playgrounds, are often actively chosen by children because these environments satisfy their needs for exploration and autonomy [44,45].

In recent years, research perspectives have increasingly shifted toward children themselves. In terms of peer interaction, children accompanied by companions tend to perceive higher spatial safety due to peer-provided social support and risk buffering, which reduce anxiety related to loneliness and environmental uncertainty [16,46]. Activity duration and frequency further shape safety perceptions. Extended engagement in outdoor spaces helps children become familiar with spatial layouts and recognize risk cues, thereby enhancing perceived safety [47]. Repeated exposure builds experience, reduces anxiety about unfamiliar environments, and strengthens overall safety perceptions [28,48]. Social and environmental contexts are also influential. Familiarity among neighbors and mutual support provide psychological security and reduce fears of being left alone. Likewise, clean and orderly environments without graffiti or litter signal care and management, reinforcing children's belief that risks are manageable [49]. More broadly, children's perceived safety is shaped by concerns such as peer bullying, animal threats, the risk of getting lost, and environmental clutter [50,51].

2.3. Associations Between Community Outdoor Public Spaces and Children's Perceived Safety

Existing studies suggest both direct and indirect pathways through which community outdoor public spaces may be associated with children's perceived safety. Through possible direct pathways, spatial characteristics may shape perceived safety by reducing immediate

risks or providing environmental safety cues. These associations involve natural materials, vegetation configuration, spatial layout, and safety facilities. Natural materials such as wood and gravel have been associated with a stronger sense of security among children [16,47]. Vegetation configuration may also relate to perceived safety in different ways. Moderately dense greenery, including open woodlands and community green spaces, may help reduce psychological stress and reinforce feelings of security, whereas overly dense vegetation can obstruct sightlines and reduce visibility, potentially increasing concerns about unknown risks. Spatial layout is similarly relevant. Open views created by low plot ratios may reduce visual blind spots and help children perceive environmental changes, while winding paths and obstructive facilities can increase cognitive difficulty and weaken perceived safety [52]. Safety infrastructure may likewise contribute to perceived safety. Protective barriers and impact-absorbing surfaces can reduce the risk of physical injury and strengthen feelings of security among both children and parents [16], while surveillance equipment and adequate lighting may provide visible safety cues and reduce anxiety associated with poorly monitored or dimly lit areas [51]. Beyond these direct associations, previous studies also suggest possible indirect pathways involving psychological and behavioral factors. Natural features such as varied terrain and water bodies can provide controlled challenges through which children develop familiarity, confidence, and a sense of mastery during autonomous exploration and risk management, which may in turn support perceived safety [27]. Similarly, public spaces with comprehensive supporting facilities, including restrooms and sunshade structures, may encourage longer activity duration. Prolonged engagement can increase children's familiarity with spatial layouts and potential risk cues, thereby contributing to greater confidence and perceived safety [47,53].

In summary, existing research provides a solid foundation for understanding the relationship between community outdoor public space characteristics and children's perceived safety. Nevertheless, several issues warrant further investigation. First, previous studies have often focused on individual dimensions and have yet to establish a comprehensive evaluation framework that integrates multiple attributes of community outdoor public spaces, including natural features, functional qualities, and safety-related conditions. Second, locally adapted measures of children's perceived safety remain under-developed. Many existing tools are based on relatively uniform contextual assumptions, which may limit the applicability of their indicators and weighting schemes across different regional and sociocultural settings. Third, empirical evidence on the associations between community outdoor public spaces and children's perceived safety remains limited, particularly regarding possible indirect associations and the role of contextual factors.

3. Materials and Methods

This study focuses on residential communities in the central urban districts of Wuhan, China (Figure 1). Wuhan is located in eastern Hubei Province at the confluence of the Yangtze and Han rivers (29°58′–31°22′ N, 113°41′–115°05′ E) and serves as a core city in the urban agglomeration of the middle reaches of the Yangtze River. The city comprises 13 administrative districts and covers an area of 8569.19 km^2. As a densely populated city undergoing continuous urban renewal, Wuhan is experiencing a shift in development priorities from rapid spatial expansion toward improvements in urban quality. In this context, community outdoor public spaces have become important areas for spatial optimization, particularly for improving environmental quality and addressing existing green space deficiencies. These conditions make the central urban communities of Wuhan a relevant, context-specific setting for examining children's perceived safety in community outdoor public spaces.

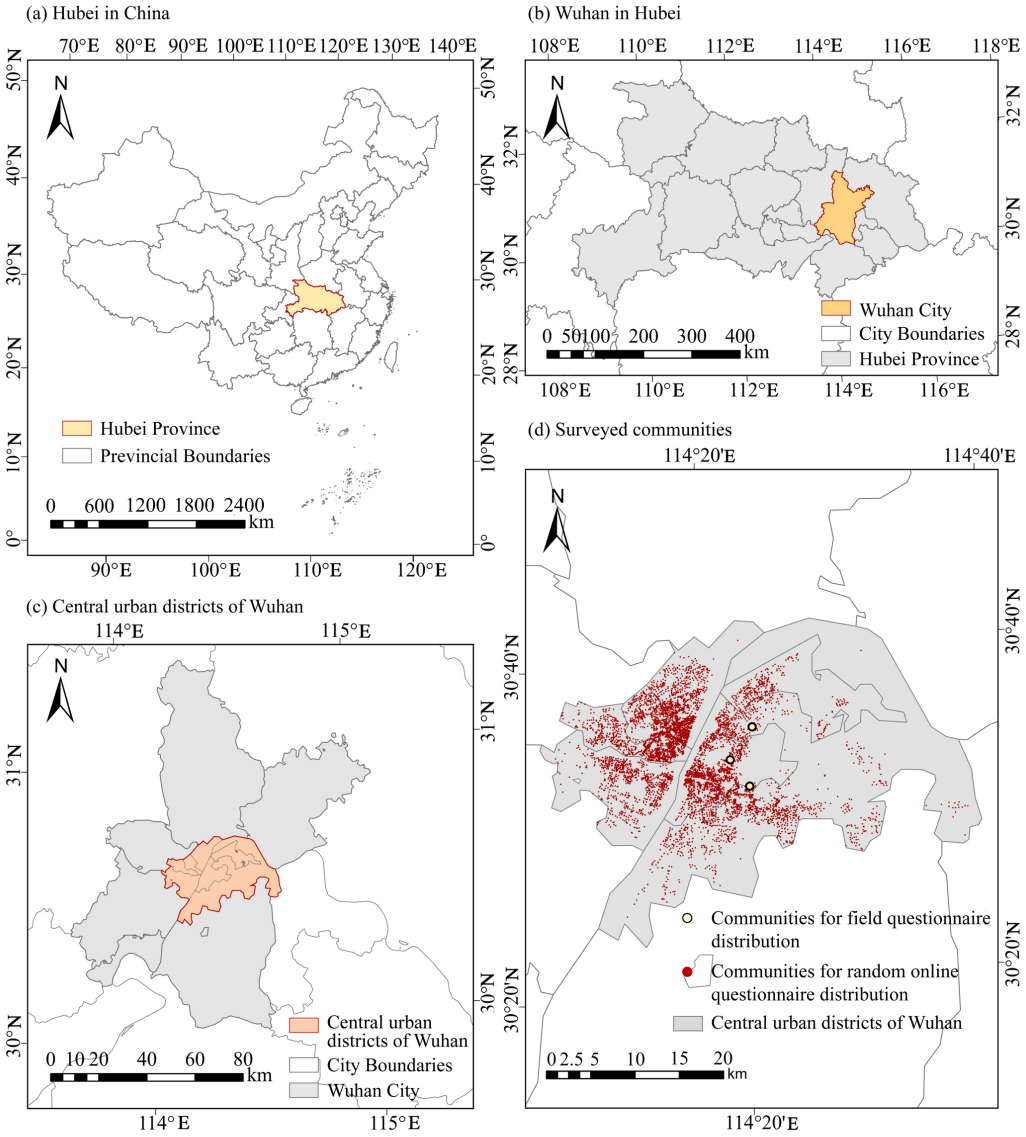

Figure 1. Location of the Study Area in Wuhan, China.

The research process comprises four main stages (Figure 2). First, a questionnaire was designed for children aged 4–18 and their parents and administered through both online and offline surveys to collect data on parent-reported assessments of community outdoor public spaces and children's self-reported perceived safety. Second, the key characteristics of community outdoor public spaces were identified, and an evaluation index system was developed across four dimensions: naturalness, functionality, protection, and attractiveness. Third, considering the characteristics of Chinese urban communities and the local context of children in China, a measurement system for children's perceived safety was developed across three dimensions: motor vehicle traffic, walking and cycling, and social interaction environments. Fourth, an analytical framework linking the physical environment, behavioral activity, and psychological perception was established. Multiple linear regression models and bootstrap analysis were then applied to examine associations between parent-reported assessments of community outdoor public spaces and children's self-reported perceived safety, as well as exploratory indirect associations involving children's outdoor behavioral activities.

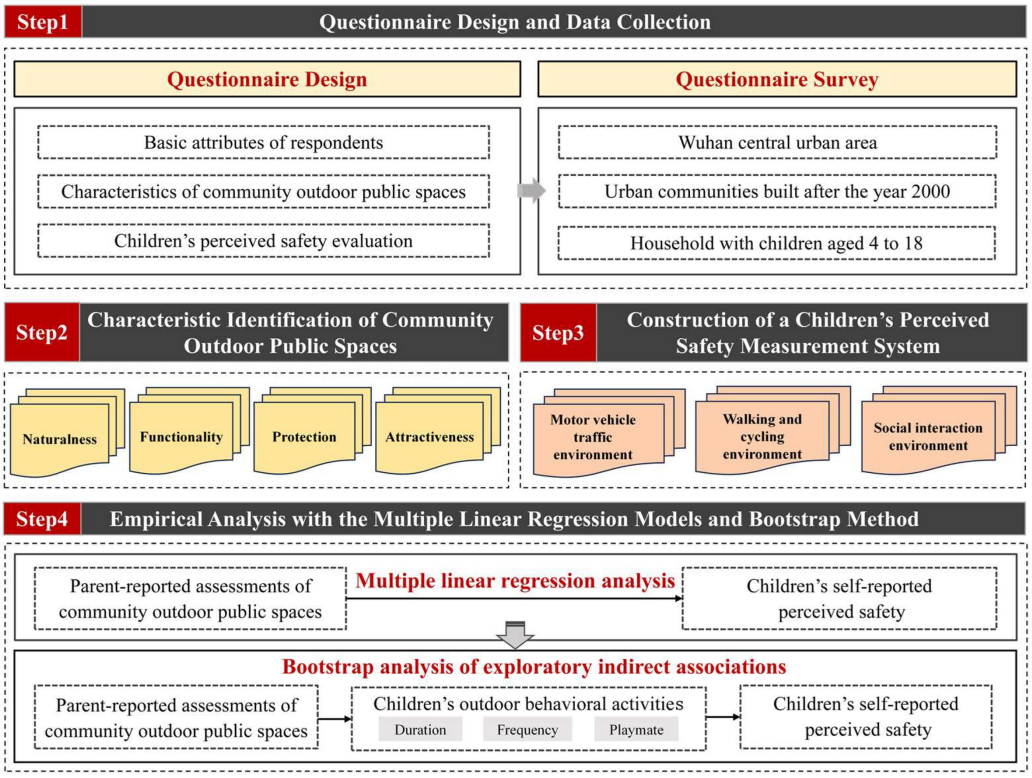

Figure 2. The framework of the study.

3.1. Data Collection

This study used residential communities in the central urban districts of Wuhan as the basic survey units (Figure 1), rather than treating specific types of outdoor public spaces as separate survey sites. The questionnaire covered public green spaces, activity plazas, pocket parks, play spaces, and street spaces commonly used by children in their daily lives. Representative photographs of these environments are provided in Figure S2. Questionnaires were administered through both offline and online channels to improve geographic coverage and participation convenience among eligible households. Offline surveys were conducted in selected residential communities (Figure 1d), allowing researchers to explain the questionnaire and provide guidance to younger children and their parents when necessary. Online surveys reduced time and location constraints on participation and helped reach families across different communities within the same study area. Both survey modes used the same questionnaire, screening criteria, and informed consent procedures.

In terms of cognitive development and cooperation with questionnaire completion, children aged 0 to 3 remain in the early stages of psychological development. They often have difficulty distinguishing subjective feelings from objective facts, show limited understanding of false beliefs, and have underdeveloped language abilities. As a result, they are unable to provide reliable responses to key questionnaire items and struggle to cooperate throughout the survey process. In contrast, children aged 4 and above demonstrate the basic capacity to complete questionnaires. They show adequate concentration and language comprehension skills. Moreover, they can clearly recall and describe their outdoor activity experiences, social interactions, and psychological perceptions, enabling reliable feedback [54]. Based on these considerations, the questionnaire was finalized for children aged 4 to 18 and their parents. Ethical approval was obtained from the Humanities and Social Sciences Ethics Committee of Wuhan University (Approval No. WHU-HSS-IRB2026069). All participants provided written informed consent after being fully briefed on the study's purpose, procedures, and

their right to withdraw at any time without penalty. All survey responses were stored securely, with access restricted exclusively to authorized research personnel.

The questionnaire comprises two parts, A and B, and takes approximately 20 min to complete. The complete English version is provided as Questionnaire S1 in the Supplementary Materials, including the parent and child sections, item wording, response options, and scoring information. Part A is completed by parents and consists of two sections. Section One collects demographic information on parents and children, together with information on children's outdoor behavioral patterns, including activity frequency, activity duration, number of playmates, and playmate types. Section Two captures parent-reported assessments of community outdoor public space characteristics across four dimensions. Part B assesses children's perceived safety using 18 items across three dimensions, rated on a five-point Likert scale. Children aged 4–6 complete this section with parental assistance, whereas those aged 7–18 complete it independently after receiving a brief explanation of the questionnaire. The survey was conducted in the central urban districts of Wuhan from 24 January to 14 February 2025, using both on-site administration and the Tencent Survey platform. Two screening criteria were applied: respondents were required to live in a residential community built after 2000 and to have at least one child aged 4–18 in the household. In households with more than one eligible child, only the oldest child was selected to participate. Residential communities built after 2000 were selected because they generally provide more public spaces and greater potential for child-friendly renewal. Responses that did not meet these criteria were excluded from the analysis. In total, 950 questionnaires were collected, of which 776 were valid, yielding a valid-response rate of 81.68%. Among the 776 valid questionnaires, 108 were completed offline (13.92%) and 668 online through the Tencent Survey platform (86.08%).

3.2. Assessment of Parent-Reported Community Outdoor Public Space Characteristics

Based on existing literature and the evaluation tool proposed by Woolley and Lowe [19], this study identified four key dimensions that may be associated with children's perceived safety and used them to construct an evaluation index system for community outdoor public spaces, as shown in Table 1. These dimensions include naturalness [24,27,55], functionality [18,47,56], protection [16,57,58], and attractiveness [16,51,58].

The naturalness dimension focuses on children's interaction with diverse natural elements and evaluates the potential of community outdoor public spaces to enhance children's perception of nature and stimulate creativity. The functionality dimension emphasizes the capacity of spaces and facilities to support a range of activity types and assesses how effectively the environment accommodates the activity needs of children at different developmental stages. The protection dimension addresses the protection of children's physical and mental well-being during outdoor activities and reflects the baseline level of environmental safety provided by community outdoor public spaces to support independent use. The attractiveness dimension highlights the positive motivational value of outdoor public spaces for children's psychological and behavioral development. It evaluates whether a space can stimulate curiosity, encourage exploration, and sustain engagement by considering its appeal, visual quality, level of challenge, developmental benefits, and suitability for different age groups. Taken together, these four dimensions comprehensively capture the core value of community outdoor public spaces in supporting children's development.

Table 1. Indicator system for parent-reported assessment of community outdoor public space characteristics.

Dimension	Indicator	Description
Naturalness	Diversity of natural materials	Number of species containing natural materials such as stones, bark, branches, soil, and fruit.
	Diversity of plants	The number of plant species features rich colors, diverse forms, pleasant aromas, and tactile qualities.
	Opportunities for participation in plant maintenance	Are there community gardens where children can participate in planting and maintenance?
	Richness of terrain	The terrain is complex and varied, featuring a challenging, explorable, and engaging degree.
	Accessibility to water and sand	The extent to which children can freely access and play with dry, granular sand and water.
Functionality	Variety of public spaces	Number of types of outdoor public spaces, including green spaces, activity plazas, pocket parks, etc.
	Age appropriateness of fixed play equipment	The variety of fixed play equipment, such as slides, meets the activity needs of children aged 4 to 18.
	Age appropriateness of movable toys	The variety of freely movable toys, such as color cards, meets the activity needs of children aged 4 to 18.
	Number of seating areas	The number and variety of public spaces are equipped with sufficient seating for rest.
	Characteristics of primary plants	Tall plants (over 3 m), medium-height plants (1–3 m), and low plants (under 1 m).
	Openness of activity areas	The extent to which the activity area is free of obstacles (such as fences) and allows children to move about freely, either individually or in groups.
	Richness of interactive activities	Number of participatory interactive activities organized by the community (children-to-children, parent–child, human–pet, human–environment, etc.).
Protection	Age-appropriate surfacing materials	Number of types of surfacing materials that meet the functional requirements for children aged 4–18, such as safety and cushioning properties.
	Adequacy of surveillance equipment	Parents' satisfaction with the adequacy of surveillance equipment (all-day, no blind spots).
	Variety of supporting facilities	Number of types of supporting facilities, including drinking water sources, public restrooms, etc.
Attractiveness	Appealing	The number of factors that attract parents and children to visit frequently includes an inviting entrance and accessibility for both parents and children.
	Visually stimulating	Featuring diverse natural topography and vibrant colors, it offers a rich visual experience.
	Challenging	Activities include sliding, running, jumping, swinging, and climbing, offering a challenging experience.
	Beneficial to child development	The number of factors conducive to the growth of children aged 4–18 includes appropriate lighting, low-noise environments, open spaces, etc.
	Suitable for all age groups	Number of age groups suitable for children aged 4–18 (4–6 years, 7–12 years, 13–18 years).

All 20 indicators of community outdoor public space characteristics were derived from parental questionnaire reports rather than independent on-site measurements by the researchers. Although some indicators refer to relatively observable attributes, such as the number of public space types, natural material types, and supporting facility types, their values were still reported by parents. Other indicators reflect more subjective evaluations, such as parents' satisfaction with surveillance adequacy. Table 1 presents the definitions of the indicators, while Table S2 in the Supplementary Materials provides the corresponding operational definitions, scoring criteria, and coding rules. Indicators based on reported numbers of types were converted into graded scores, whereas evaluative indicators were measured using Likert-type scales. The 20 indicators were entered separately into the regression models and were not aggregated into a single composite environmental score.

3.3. Assessment of Children's Perceived Safety in Outdoor Activities

Children's perceived safety refers to the extent to which children feel free from danger or threat during outdoor activities. It reflects children's subjective evaluation of the safety of their surrounding environment while playing and represents a psychological state marked by the absence of perceived danger, fear, or threat [16]. Drawing on the localized adaptation of the international Child Friendly Community assessment tool, this study establishes a measurement system with three dimensions: motor vehicle traffic environment, walking and cycling environment, and social interaction environment (Table 2). This framework aligns with international research consensus and addresses the practical needs of children in China [39,51].

The motor vehicle traffic environment assesses the impact of vehicle traffic on children's perceived safety by examining traffic volume near activity areas and the degree to which these conditions generate feelings of unease among children [16,51,58]. The walking and cycling environment dimension is included because children's outdoor activities mainly involve walking and cycling [47,51,56]. To reflect the characteristics of Chinese urban communities and children's practical needs, localized indicators were incorporated into this dimension, including the availability of emergency assistance devices and access to public restrooms. As noted earlier, children's perceived safety extends beyond the absence of physical risks to encompass psychological security within social interactions. In the Chinese cultural context, factors such as neighborhood surveillance, community inclusivity, interactions with strangers, and animal-related threats play an important role in shaping children's perceived safety [41,50]. Accordingly, the social interaction environment dimension uses four indicators: social security, perceived security, physical health, and safety awareness, thereby overcoming the limitations of assessments based solely on physical environmental factors. A five-point Likert scale is employed, with response options ranging from strongly disagree to strongly agree.

To examine the latent structure of the 18-item perceived-safety scale, exploratory factor analysis (EFA) was conducted and yielded a three-factor solution. The complete factor-analysis procedure and rotated factor-loading matrix are provided in the Supplementary Methods and Table S4. Overall, the EFA results support a generally interpretable three-factor latent structure, providing empirical support for the dimensional organization of the perceived-safety scale. EFA was used to examine the scale structure rather than to determine item weights. The final perceived-safety score was calculated using combined weights derived from the analytic hierarchy process (AHP) and the entropy weighting method. Positively and negatively worded items were aligned in the same interpretive direction during entropy standardization. Detailed procedures for item-direction treatment and weighting are provided in Table S3 and the Supplementary Methods.

Table 2. Children's outdoor perceived safety measurement system.

Dimension	Indicator	Evaluation Project
Motor Vehicle Traffic Environment	Traffic control	B7 There is a high volume of traffic around the area where I operate, which makes me feel unsafe.
Walking and Cycling Environment	Passage guarantee	B12 I'm afraid of getting hurt while playing in the community's activity areas, such as falling, slipping, or getting bumped.
	Traffic node transit guarantee	B6 There are many intersections around the area where I live, which makes me feel unsafe. B14 I can read road signs and reach my destination accurately and quickly.
	Visual assurance and alerts	B13 Signage, lighting, and fencing have been installed throughout the community to ensure my safety.
	Emergency device	B15 When I get hurt while playing in the community, I can find places for treatment, such as community health stations and first-aid equipment. B16 When I feel unsafe or uneasy while playing in the neighborhood, I can find places that offer help and protection, such as community security personnel and surveillance patrols.
	Public restroom availability	B17 I can safely and conveniently use clean public restrooms within my community.
Social Interaction Environment	Social security	B9 I see/hear: acts of violence/assaults/harassment/arguments within the community.
	Perceived security	B1 I trust my neighborhood. B2 I am very familiar with my neighborhood. B3 In the community, I feel respected, treated equally, and welcomed with kindness. B4 I worry about encountering strangers who might greet me in the neighborhood or about being taken away by strangers. B5 I'm concerned about encountering unattended animals in the neighborhood, especially large dogs. B11 I've noticed some dilapidated, graffiti-covered, abandoned buildings near my home.
	Physical health	B8 I often smell unpleasant, pungent odors near my home (such as car exhaust fumes, garbage bin smells, etc.). B10 I can hear a lot of noise where I live.
	Safety awareness	B18 I can relax and have fun playing within the community.

3.4. Multiple Linear Regression Models and Bootstrap Analysis

To identify key factors associated with children's perceived safety in community outdoor public spaces and to explore possible statistical pathways, this study employed a quantitative approach combining multiple linear regression with bootstrap analysis [59,60]. Children's individual characteristics, including age (treated as a continuous variable) and gender, were included as control variables. The analyses focused on overall-sample associations among children aged 4–18. Model I included children's individual characteristics together with 20 parent-reported variables representing four dimensions of community outdoor public space characteristics. Model II additionally incorporated six variables describing children's outdoor behavioral activities. Model III further included respondent

background characteristics, including parental gender, age, educational attainment, and community type.

After identifying factors associated with children's perceived safety using multiple linear regression, bootstrap analysis was employed to explore indirect statistical associations along the prespecified pathways. The analysis used 1000 resampling iterations with a fixed random seed of 12,345 [61–63]. Within an analytical framework linking the physical environment, behavioral activity, and psychological perception, the study examined relationships among parent-reported assessments of community outdoor public spaces, children's outdoor behavioral activities, and children's self-reported perceived safety. All data analyses were conducted using StataMP 18 (64-bit).

4. Results and Analysis

4.1. Descriptive Analysis of Questionnaire Data

The internal consistency of the children's perceived safety scale and the suitability of the data for factor analysis were assessed using Stata 18.0. Cronbach's α was 0.901, indicating good internal consistency. The Kaiser–Meyer–Olkin (KMO) value was 0.925, and Bartlett's test of sphericity was significant, confirming that the data were suitable for the exploratory factor analysis described in Section 3.3. This study included three age groups: 4 to 6 years, 7 to 12 years, and 13 to 18 years. Children aged 7 to 12 formed the largest group at 50.00 percent, followed by those aged 4 to 6 at 28.48 percent and those aged 13 to 18 at 21.52 percent. The gender distribution was balanced, with males and females accounting for 46.65 percent and 53.35 percent of the sample, respectively (Figure S1). Independent sample *t*-tests and analysis of variance showed no significant differences by gender ($t = -0.7129$, $p = 0.4761 > 0.05$) or age group ($F = 0.52$, $p = 0.5919 > 0.05$).

Statistical analysis of children's outdoor behavioral characteristics indicates that the most common activity frequency is one to two times per week, accounting for 41.24 percent of cases. Activity duration is largely concentrated between 0.5 and 1.5 h per session, representing over 69 percent of observations, and 52.47 percent of children engage in activities lasting more than one hour, suggesting that short- to medium durations are predominant. Activity plazas and public green spaces were the most frequently reported activity locations, reported by 76.68% and 71.81% of respondents, respectively. Regarding social participation, two playmates is the most common group size at 52.84 percent. Parental accompaniment is the most frequent playmate type at 56.44 percent, while 3.48 percent of children play alone. In terms of peer gender composition, most children interact with both same-sex and opposite-sex peers, accounting for 76.93 percent of cases. More detailed information is provided in Figure 3 and Table S1.

The item-response distributions provide an overview of children's reported perceptions across the three dimensions. Responses to most items were concentrated in the neutral, agree, and strongly agree categories. For the motor vehicle traffic environment dimension, approximately 40% of children reported positive perceptions of traffic control, a lower proportion than that observed for the other two dimensions. In the walking and cycling environment, positive responses to visual assurance and warning information accounted for approximately 53%, whereas negative responses to emergency facilities and public restroom availability accounted for approximately 30%. In the social interaction environment, several items received combined agree and strongly agree responses exceeding 60% (Figure S3).

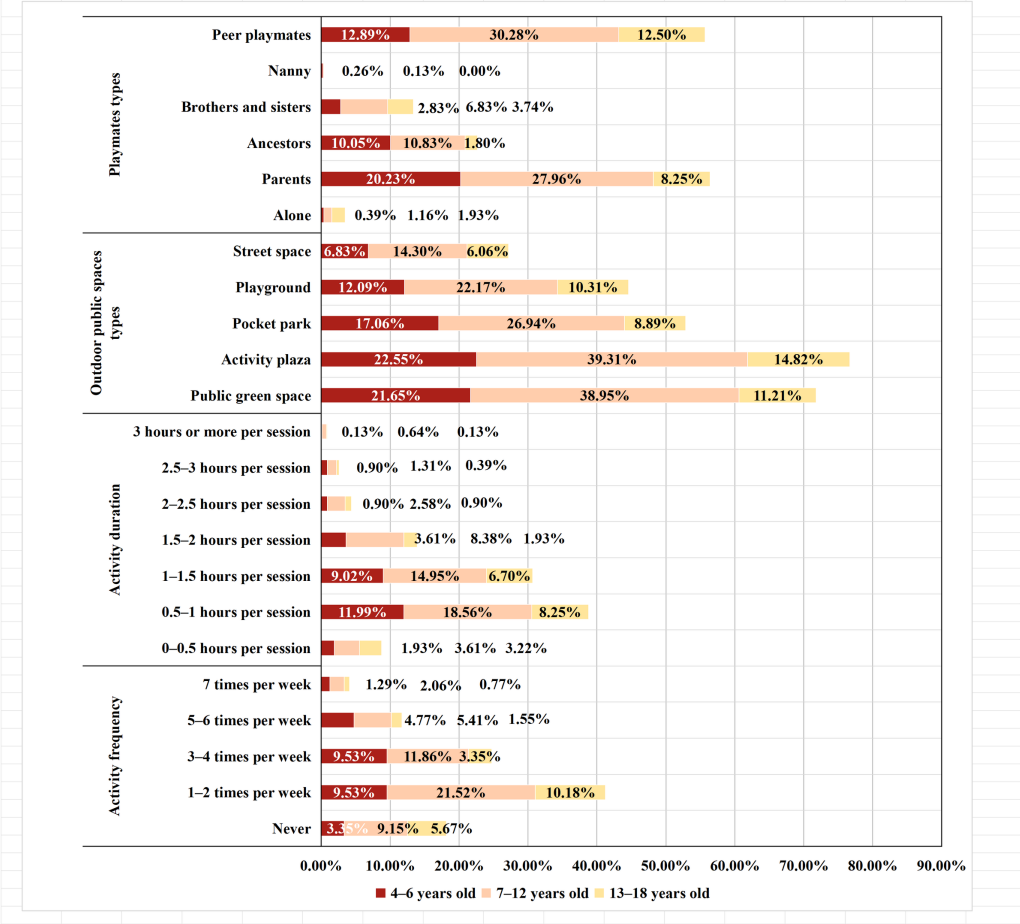

Figure 3. Characteristics of children's outdoor behavioral activities.

4.2. Examining Associations Between Community Outdoor Public Spaces and Children's Perceived Safety

To address RQ1 and RQ2, three multiple linear regression models were constructed, as shown in Table 3. Children's gender and age were included as control variables, while community outdoor public space characteristics and children's outdoor behavioral activities were specified as independent variables. Children's perceived safety was treated as the dependent variable. Diagnostic tests showed that variance inflation factor values for all three models were below 2, indicating no multicollinearity among the independent variables. In addition, the R-squared values increased with the successive inclusion of variables, and the F change tests remained statistically significant at levels below 0.001. These findings indicate progressively stronger explanatory power across the models, as presented in Table 4.

Based on the regression results, characteristics of community outdoor public spaces are significantly associated with children's perceived safety, providing an affirmative answer to RQ1. Regarding RQ2, several spatial characteristics show notable positive associations. The variety of supporting facilities has the strongest association ($B = 0.105$, $p < 0.001$), followed by the age appropriateness of movable toys ($B = 0.097$, $p < 0.001$) and terrain richness ($B = 0.059$, $p < 0.001$). By contrast, several characteristics show significant negative associations. The adequacy of surveillance equipment shows the strongest negative association with perceived safety ($B = -0.212$, $p < 0.001$), followed by the age appropriateness of fixed play equipment ($B = -0.103$, $p < 0.001$), suitability for all age groups ($B = -0.079$, $p < 0.001$), characteristics of primary plants ($B = -0.074$, $p < 0.01$), accessibility to water and sand ($B = -0.057$, $p < 0.001$), and diversity of natural materials ($B = -0.048$, $p < 0.001$). Age-appropriate surfacing materials showed a negative association in Model I that did

not reach conventional statistical significance (B = −0.033, $p = 0.062$), and a statistically significant negative association in Model III (B = −0.034, $p = 0.047$).

Table 3. Multiple linear regression results for children's perceived outdoor safety.

Dimension	Variable	Model I		Model II		Model III	
		Beta	*p*	Beta	*p*	Beta	*p*
Personal Attributes	Child's gender	0.011	(0.724)	0.006	(0.844)	0.011	(0.740)
	Child's age	0.019	(0.414)	−0.011	(0.654)	−0.015	(0.591)
Naturalness	Diversity of natural materials	−0.048 ***	(0.000)	−0.048 ***	(0.000)	−0.045 ***	(0.000)
	Diversity of plants	−0.005	(0.826)	−0.003	(0.873)	0.006	(0.775)
	Opportunities for participation in plant maintenance	0.009	(0.814)	−0.000	(0.992)	−0.004	(0.923)
	Richness of Terrain	0.059 ***	(0.001)	0.060 ***	(0.001)	0.057 ***	(0.001)
	Accessibility to water and sand	−0.057 ***	(0.000)	−0.055 ***	(0.000)	−0.051 ***	(0.000)
Functionality	Variety of public spaces	−0.025	(0.114)	−0.020	(0.264)	−0.022	(0.211)
	Age appropriateness of fixed play equipment	−0.103 ***	(0.000)	−0.102 ***	(0.000)	−0.095 ***	(0.000)
	Age appropriateness of movable toys	0.097 ***	(0.000)	0.096 ***	(0.000)	0.090 ***	(0.000)
	Number of seating areas	−0.007	(0.717)	−0.002	(0.904)	−0.005	(0.762)
	Characteristics of primary plants	−0.074 ***	(0.003)	−0.066 ***	(0.009)	−0.063 **	(0.011)
	Openness of activity areas	−0.023	(0.206)	−0.019	(0.293)	−0.016	(0.386)
	Richness of interactive activities	0.016	(0.383)	0.014	(0.416)	0.015	(0.407)
Protection	Age-appropriate surfacing materials	−0.033 *	(0.062)	−0.032 *	(0.059)	−0.034 **	(0.047)
	Adequacy of surveillance equipment	−0.212 ***	(0.000)	−0.210 ***	(0.000)	−0.213 ***	(0.000)
	Variety of supporting facilities	0.105 ***	(0.000)	0.106 ***	(0.000)	0.106 ***	(0.000)
Attractiveness	Appealing	−0.018	(0.400)	−0.026	(0.223)	−0.024	(0.234)
	Visually stimulating	0.001	(0.975)	−0.003	(0.886)	0.002	(0.947)
	challenging	−0.007	(0.731)	0.001	(0.977)	0.001	(0.972)
	Beneficial to child development	−0.011	(0.385)	−0.010	(0.397)	−0.011	(0.371)
	Suitable for all age groups	−0.079 ***	(0.000)	−0.077 ***	(0.000)	−0.077 ***	(0.000)
Children's Outdoor Behavioral Activities	Activity space			0.002	(0.923)	0.007	(0.661)
	Activity frequency			−0.028 *	(0.077)	−0.026 *	(0.095)
	Activity duration			0.030 **	(0.032)	0.026 *	(0.055)
	Playmate type			−0.031	(0.120)	−0.030	(0.122)
	Peer playmate types			−0.037	(0.176)	−0.045 *	(0.099)
	Number of playmates			−0.051 **	(0.012)	−0.054 ***	(0.007)
Other Background Information	Parental gender					−0.104 ***	(0.001)
	Parental age					−0.032	(0.287)
	Parental education level					−0.042 **	(0.026)
	Community type					−0.041 ***	(0.006)

Note: Dependent variable: Perceived Safety; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4. Fitting degree of multiple regression model for children's perceived safety.

Model	R^2	F Change	Significant F Change
I	0.437	F (22,753) = 31.10	0.000
II	0.449	F (28,747) = 25.64	0.000
III	0.464	F (32,743) = 23.87	0.000

Children's outdoor behavioral characteristics were also related to perceived safety. Activity duration showed a positive association (B = 0.030, $p < 0.05$), whereas the number of playmates showed a negative association (B = −0.051, $p < 0.05$). In addition, parental gender (B = −0.104, $p < 0.001$), parental educational attainment (B = −0.042, $p < 0.05$), and community type (B = −0.041, $p < 0.001$) were significantly associated with children's perceived safety. Overall, the findings indicate that perceived safety is related not only to community outdoor public space characteristics but also to selected behavioral and background factors.

4.3. Exploratory Pathway Analysis of Associations with Children's Perceived Safety

The multiple linear regression results indicated a positive association between outdoor activity duration and perceived safety (Table 3). To address RQ3, an exploratory analysis was conducted to examine indirect associations involving activity duration (Table 5). The estimated indirect associations for spatial appeal and public space variety were 0.005 and 0.004, respectively. The lower bounds of their reported 95% bootstrap confidence intervals were 0.000. Overall, the results suggest that outdoor activity duration may serve as a potential linking factor between selected community outdoor public space characteristics and children's perceived safety.

Table 5. Results of the exploratory analysis of indirect associations.

Term	Total Association (c)	Association Coefficient (a)	Association Coefficient (b)	Indirect Association (a × b)	95% Bootstrap CI for Indirect Association	Direct Association (c′)
Spatial appeal → Outdoor activity duration → Perceived safety	−0.022	0.159 **	0.028 *	0.005	[0.000, 0.011]	−0.026
Variety of public spaces → Outdoor activity duration → Perceived safety	−0.017	0.128 **	0.028 *	0.004	[0.000, 0.008]	−0.021

Note: → This refers to an exploratory path direction. a represents the association between the community outdoor public space characteristic and outdoor activity duration; b represents the association between outdoor activity duration and perceived safety. a × b represents the estimated indirect association. c and c′ represent the total and direct associations, respectively. * $p < 0.05$; ** $p < 0.01$.

5. Discussion

5.1. Community Outdoor Public Space Characteristics and Outdoor Activity Duration in Relation to Children's Perceived Safety

To address RQ1 and RQ2, this section discusses the patterns of association identified in Table 3. Within the naturalness dimension, terrain richness is positively associated with children's perceived safety. This finding is consistent with previous studies suggesting that varied topography can support self-directed exploration and greater familiarity with the environment [11,24]. Features such as gentle slopes and shallow depressions may provide children with opportunities for exploration while fostering a sense of familiarity

and control. In contrast, accessibility to water and sand and the diversity of natural materials are negatively associated with perceived safety. These findings add nuance to the established emphasis on natural elements in children's play environments [18,37,46], suggesting that children's experiences may depend not only on the presence or diversity of natural features but also on how they are organized, maintained, accessed, and used. Spatial boundaries, material arrangement, and adult accompaniment may all shape children's interactions with these elements. Natural materials can enrich opportunities for creative and sensory play, yet their contribution to perceived safety may vary across different conditions of use. Taken together, the results suggest that the relationship between naturalness and children's perceived safety depends on the specific characteristics and use conditions of natural elements, with varied terrain showing particular value in supporting exploration and positive spatial experiences.

Within the functionality dimension, the age appropriateness of fixed play equipment is negatively associated with perceived safety, whereas the age appropriateness of movable toys shows a positive association (Table 3). This contrast may partly reflect differences in how these facilities accommodate children's actual abilities and activity preferences. Previous research on differences between parent and child perceptions provides a useful basis for interpretation [64,65]. Parents may assess age appropriateness largely according to designated age ranges or intended functions, while children's experiences may also depend on comfort, ease of use, and opportunities for autonomous engagement. Movable toys, by comparison, may offer greater flexibility in activity choice and allow children to adapt play to their own preferences. This interpretation is consistent with literature emphasizing children's independence and neighborhood connectedness [66]. Taken together, these contrasting associations suggest that children's perceived safety may relate not only to whether facilities are considered age-appropriate, but also to how well they accommodate individual abilities, preferences, and opportunities for flexible use [67]. This perspective extends the interpretation of age appropriateness beyond fixed provision by drawing attention to the adaptability of play opportunities. Primary plant characteristics also show a negative association with perceived safety (Table 3), indicating that the functional qualities of planting may also be relevant to children's spatial experiences alongside play facilities.

Within the protection dimension, parents' ratings of surveillance adequacy are negatively associated with children's perceived safety, whereas supporting facility diversity shows a positive association (Table 3). The surveillance indicator captures parental assessments of adequacy rather than objective device counts or coverage, or children's attitudes toward surveillance. This pattern contrasts with the emphasis on technical protection in adult assessments of safety and can be considered alongside previous research on differences between parental and child perceptions [44,65]. Several contextual factors may help explain this pattern. Parental assessments of technical protection may differ from children's spatial experiences. Areas with higher perceived risks or greater management needs may place greater emphasis on surveillance, while some surveillance installations may also be perceived as cues of risk. These possibilities draw attention to a potential mismatch between adult safety assessments and children's subjective spatial experiences. Bringing parent-reported assessments and children's self-reported perceived safety into the same analytical framework helps reveal this potential mismatch and provides a more comprehensive account of whose experiences are represented in evaluations of community safety. By contrast, the positive association with supporting facility diversity may reflect the role of such facilities in supporting children's everyday activities, consistent with previous research on children's understanding and use of their environments [39]. Supporting facilities such as drinking water points and first-aid stations may help children meet basic needs within familiar activity areas. Age-appropriate surfacing materials also show a negative association,

although its statistical significance varies across models (Table 3). This pattern may be related to differences between parents' assessments of material suitability and children's experiences of surface conditions and maintenance during everyday use [27].

Within the attractiveness dimension, suitability for all age groups is negatively associated with children's perceived safety (Table 3). Previous research suggests that children's needs and spatial experiences may vary across developmental stages [18,68]. One possible explanation is that a general assessment of inclusiveness may not fully reflect how well a space meets the needs of individual children. Designing spaces to accommodate all age groups often requires balancing different preferences for exploration, independence, and social interaction, while shared-use conditions and patterns of adult accompaniment may also shape children's experiences [69]. The observed association therefore adds an important dimension to the concept of inclusive provision. A space regarded by adults as suitable for all ages may still be experienced differently by individual children. The findings suggest that child-friendly design should consider not only broad age coverage but also the degree to which spaces can respond to age-related differences in activity needs and spatial experience. This points to the value of adaptable and differentiated spatial provision that can accommodate children at different developmental stages while maintaining opportunities for shared use.

The associations with community type, parental gender, and parental educational attainment provide additional contextual information (Table 3). Differences in neighborhood support and social cohesion may help explain the association with community type, as suggested by previous research on community activities [56]. Similarly, variations in parental risk awareness and communication may be relevant to the associations with parental background characteristics [69]. Together, these patterns situate children's perceived safety within the broader social and family contexts of everyday community life.

Beyond these environmental associations, examining how children actually use community outdoor spaces provides an important behavioral perspective on the findings. To address RQ3, the pathway analysis examined outdoor activity duration as a potential link between spatial appeal, the variety of public spaces, and children's perceived safety (Table 5). Positive indirect associations were observed for both pathways, suggesting that activity duration may serve as a connecting factor between selected environmental characteristics and perceived safety. Within the E-B-P framework, activity duration gives empirical expression to the behavior component by linking environmental assessments with children's sustained engagement in outdoor spaces. This extends the analysis from what community outdoor spaces provide to how children engage with and continue to use these spaces in everyday life.

Previous research suggests that appealing spaces and diverse activity settings can support children's engagement in outdoor activities [19,56]. Features such as inviting entrances and accessibility for both parents and children may encourage exploration and sustained participation. Similarly, a variety of public spaces, including green areas, activity plazas, and pocket parks, can provide diverse settings for everyday activities. Such diversity may reduce the monotony of repetitive environments and accommodate changing activity preferences [56]. Repeated use may, in turn, foster greater familiarity with spatial layouts and a stronger sense of control, providing one possible explanation for the positive association between activity duration and perceived safety [3,58]. Through repeated encounters with familiar places, children may become more comfortable selecting activities and navigating their surroundings. The positive indirect associations observed for both spatial appeal and public space variety suggest that engaging and diverse settings may be related to perceived safety through more sustained participation. These findings extend the discussion beyond individual environmental features by drawing attention to children's

actual engagement with community outdoor spaces. Together with the differing associations across environmental dimensions, they suggest that perceived safety is related not only to how spaces are assessed by adults, but also to how they are experienced and used by children. In this sense, the findings add a behavioral dimension to the environment–behavior–perception framework by linking spatial qualities with the continuity of children's everyday outdoor activities.

5.2. Planning Implications for Child-Friendly Community Outdoor Public Spaces

This study integrates parent-reported assessments of community outdoor public spaces, children's outdoor behavioral activities, and children's perceived safety within a unified analytical framework. Based on the findings, the planning implications center on natural elements, facility adaptability, protective conditions, and opportunities for sustained engagement. Planning attention should therefore extend beyond the presence of environmental features to how well they accommodate children's abilities, support continued use, and are experienced in everyday activities. The associations identified in this study help highlight key priorities for the evaluation and improvement of community outdoor spaces, providing a basis for developing child-friendly planning strategies that respond to local conditions.

Within the naturalness dimension, the positive association with terrain richness suggests the value of varied and explorable terrain in children's everyday environments. By contrast, the negative associations with water and sand accessibility and natural material diversity highlight the importance of how natural elements are organized, maintained, bounded, and used, rather than their mere presence. These findings suggest that naturalness should be considered not only in terms of environmental richness, but also in relation to how children can safely and meaningfully engage with natural features. Previous research further supports balancing opportunities for exploration with appropriate risk management and adult accompaniment [18,39]. For functionality, the contrasting associations between fixed play equipment and movable toys draw attention to the fit between facility provision and children's actual abilities and preferences. Flexible play opportunities and diverse supporting facilities may better accommodate changing activities and everyday needs. Evaluating this fit gives more practical meaning to naturalness and functionality than simply counting environmental elements or assigning age labels. Research on children's differing spatial needs also supports adapting these principles to local patterns of use and involving children and caregivers in design decisions [15,68].

From a protection perspective, physical safeguards should be considered alongside children's psychological comfort. The negative association with parents' ratings of surveillance adequacy highlights the value of incorporating children's experiences into assessments of technical protection. Community safety evaluation can therefore move beyond facility provision alone to consider how children perceive, use, and respond to protected spaces, together with information on maintenance and everyday use conditions. Previous research on children's outdoor experiences further supports balancing independence, adult accompaniment, and risk management [70]. These considerations suggest that decisions regarding planting, spatial boundaries, and surfacing should respond to children's actual use patterns and everyday needs, with post-implementation evaluation providing feedback for subsequent adjustment.

From an attractiveness perspective, the exploratory associations involving spatial appeal, public space variety, and activity duration highlight the importance of opportunities for sustained engagement. A diverse range of public spaces, including green areas, activity plazas, pocket parks, and sports fields, can provide children with varied choices for everyday activities. Planning can therefore focus not only on the provision of these spaces but also on their continuing appeal and accessibility, enabling children to develop familiar and sustained

patterns of use. Previous studies further emphasize the value of children's participatory input and attention to environmental features in natural playground design [71,72], while neighborhood familiarity and social relationships have also been identified as important considerations in community planning [73,74].

Together, these insights support involving children in space evaluation and design and creating opportunities for community activities and neighborhood interaction. Their application should respond to local needs and incorporate children's experiences throughout the process of implementation and subsequent evaluation. Taken together, the findings suggest a shift in planning attention from the simple provision of environmental features toward the fit between spatial qualities, children's everyday activities, and their perceived safety. Opportunities for sustained engagement may provide an important connection among these dimensions.

5.3. Limitations and Future Research Directions

Several limitations should be considered when interpreting the findings. First, the cross-sectional design does not establish temporal ordering or causality. Outdoor activity duration and perceived safety may be bidirectionally related, and bootstrap estimates of indirect associations cannot determine their temporal sequence. Second, all community outdoor public space indicators were derived from parental questionnaire reports rather than objective site measurements, and some involved subjective evaluations. Differences between parental assessments and children's perceptions were not systematically examined, while the mixed online/offline survey design may also have introduced mode-related differences [18]. Third, the sample covered children aged 4–18. Although age was controlled for in the regression models, potential age-related heterogeneity may remain, as no age-stratified or interaction analyses were conducted. Parental assistance for children aged 4–6 may also have influenced their responses. Finally, the sample was limited to centralized residential communities built after 2000 in central Wuhan, and data were collected only during winter [21], which may limit generalizability across community types, locations, and seasons. Future research could address these limitations through longitudinal or quasi-experimental designs, objective environmental measurements combined with questionnaire assessments, more standardized procedures across survey modes, and child-appropriate methods that support independent responses. Age-specific analyses and comparisons across different community types, cities, and seasons would further clarify the robustness and broader applicability of the findings.

6. Conclusions

Guided by the physical environment–behavioral activity–psychological perception framework, this study examined associations between parent-reported assessments of community outdoor public space characteristics and children's self-reported perceived safety, while also exploring outdoor activity duration as a potential linking factor. The findings show that supporting facility diversity, age appropriateness of movable toys, and terrain richness are associated with higher perceived safety, whereas parents' ratings of surveillance adequacy, age appropriateness of fixed play equipment, accessibility to water and sand, diversity of natural materials, and suitability for all age groups are associated with lower perceived safety. Exploratory indirect associations involving outdoor activity duration further link spatial appeal and public space variety with perceived safety. Together, these findings connect environmental assessments with children's outdoor behavior and draw attention to possible differences between adult evaluations and children's spatial experiences.

Based on these findings, the study proposes planning considerations for child-friendly community outdoor public spaces that emphasize the organization and use of natural ele-

ments, facility adaptability, protective conditions, spatial attractiveness, and opportunities for sustained engagement. The findings highlight the importance of considering physical safety alongside psychological comfort and balancing natural exploration with appropriate risk management. By integrating environmental characteristics, behavioral activities, and perceived safety within a unified analytical framework, this study extends research on child-friendly urban environments and provides practical insights for improving community outdoor public spaces around children's everyday experiences.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/buildings16214376/s1, Figure S1. Questionnaire sample characteristics by gender and age group, with selected survey scenes. Figure S2. Representative community outdoor public spaces in the surveyed residential communities. Figure S3. Distribution of children's responses to perceived-safety items across the three dimensions. Table S1. Questionnaire data statistics of children's outdoor behavioral activities. Table S2. Indicator system and 1–5 scoring for parent-reported assessments of community outdoor public space characteristics. Table S3. Children's outdoor perceived safety measurement system and item-direction treatment. Table S4. Factor Loading for Each Indicator of Children's Safety Perception After Rotation. Questionnaire S1. Full English questionnaire used in the study.

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