



# Influence of Neighborhood Built Environments on the Outdoor Free Play of Young Children: a Systematic, Mixed-Studies Review and Thematic Synthesis

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**Abstract** Urban environments shape early childhood exposures, experiences, and health behaviors, including outdoor free play, influencing the physical, cognitive, social, and emotional development of young children. We examined evidence for urban or suburban built environment influences on outdoor free play in 0–6-year-olds, considering potential differences across gender, culture, and geography. We systematically searched seven literature databases for relevant qualitative, quantitative, and mixed methods studies: of 5740 unique studies, 53 met inclusion criteria. We assessed methodological quality and thematically synthesized findings from included studies. Three broad

themes, features of spaces for play, routes, and social factors intersected to influence the availability, accessibility, and acceptability of neighborhoods for young children’s outdoor free play across diverse cultural and geographic contexts. Proximity to formal or informal space for play, protection from traffic, pedestrian environment, green and natural environments, and opportunity for social connection supported outdoor free play. Family and community social context influenced perceptions of and use of space; however, we did not find consistent, gendered differences in built environment correlates of outdoor free play. Across diverse contexts, playable neighborhoods for young children provided nearby space for play, engaging routes protected from traffic and facilitated frequent interaction between people, nature, and structures.

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Experiences during developmental periods in early childhood sculpt neural connections, building brain architecture and competencies that impact life-long wellbeing and health trajectories [1]. Young children’s outdoor play is linked to positive health outcomes, and exposure to nature is associated with mental wellbeing, cognitive and social development, and fewer behavioral problems [2–5]. Children are intrinsically motivated

to play, spontaneously engaging in joy-inducing activities that build physical, cognitive, social, and emotional skills [6, 7]. Though strongly associated with physical activity (PA), much of the developmental value that children receive from play derives from its intrinsic “unpredictability, spontaneity, goal-lessness and personal control, rather than directly from its content” [8]. Through play, children simulate and overcome hypothetical challenges, enhancing adaptive capabilities, resilience, and self-regulation [9, 10]. Free play permits both problem finding and problem solving; cultivating creativity and unstructured time has been associated with higher executive function [11, 12]. Importantly, play is central to children’s own conception of wellbeing [13]. Despite these benefits, children’s need to play is often overlooked and adult activity patterns prioritized in neighborhood design [14]. With fewer opportunities to experience other environments, children living in poverty may be most impacted by un-playable neighborhoods [15, 16]. In a rapidly urbanizing world, it is critical to understand how built environments shape early childhood exposures, experiences, and behaviors, including outdoor free play (OFP).

Previous work on urban environments and child movement behaviors, including OFP, has often focused on middle childhood and youth, as parental supervision decreases and independent mobility increases [17]. Several recent reviews examined correlates of outdoor play, time, or physical activity [18–21], considering broader age ranges [18–20], older ages [21], or exclusively qualitative [18] or quantitative evidence [19, 20, 22]. Lambert et al. [19] found moderate evidence that lower traffic volumes, yard access, and neighborhood greenness was associated with outdoor time in early to mid-childhood and adolescence. Lee et al. [20] identified individual, parental, home, and community physical and social factors, influencing outdoor play and time for 3–12-year-olds. Neighborhood characteristics, including learning and recreation destinations, play space, playgrounds, yards, sidewalks, roundabouts, and low traffic-volume roads were associated with more, and walkability, traffic crash density, and intersections with less outdoor play or time [20]. In a review including 7–14 year-olds, traffic safety, social safety, social norms, cohesion, and playmates, parks and greenspace were correlated with outdoor play [21]. The magnitude and direction of effects on child movement behaviors have been shown to vary

by age. High intersection density was associated with significantly less physical activity in 4-year-old boys, but more in 14-year-old boys [23], and proximity was more important than park size or amenities for 3–5-year-olds compared to older children [24]. These differences reflect the shifting dynamics of child motivations and abilities and parental control and perceptions of risk across developmental stages. Given the importance of experiences and environments to early development, a comprehensive understanding of how neighborhood environments uniquely influence young children’s outdoor free play is needed to inform inclusive urban policy and design. To our knowledge, no review has yet examined literature on this topic specifically in early childhood. To address this gap, we systematically review and synthesize evidence for neighborhood built environment influences on outdoor free play in children, 0–6 years, considering potential differences across gender, culture, and geography. We synthesize quantitative, qualitative, and mixed methods evidence to address the questions:

1. What features or characteristics of neighborhood built environments influence outdoor free play for children, ages 6 and under?
2. What features or characteristics of neighborhood built environments act as motivators, facilitators, or barriers to outdoor free play for children, ages 6 and under?
3. How do neighborhood built environment influences on young children’s outdoor free play differ across child gender, cultures, and geographies?

## Methods

### Search Strategy

We prospectively registered our review protocol (PROSPERO, CRD42020173288) and searched seven research databases: Avery Index, ERIC, MEDLINE, CINAHL, PsycInfo, SportDiscus, and Web of Science for empirical research from peer-reviewed journals, theses, and dissertations without time period or language restrictions to September 26, 2022. We hand-searched Children, Youth, and Environments (CYE is not indexed in the searched databases), consulted experts, and carried out forward/backward citation

tracking of included papers to identify additional relevant articles. This yielded 18 studies for screening, of which two from CYE met inclusion criteria.

### Inclusion and Exclusion Criteria

The search strategy included terms related to the population, children, 0–6 years; the exposure, neighborhood built environments and the outcome, outdoor free play (Table 1, Supplementary File 1).

We define outdoor free play as child-directed, outdoor activities outside of school hours or organized and adult-directed settings. This definition includes active play but does not require that children necessarily engage in physical activity: child-motivated engagement in social or focused, non-physically active outdoor pursuits, such as “playing house,” building pebble towers, or watching ants is included. This definition excludes activities that involve electronic devices. We limited our review to outdoor play outside of formal programs as their context and content may affect children’s access and use of outdoor environments. We included physical activity as an outcome only when specific to OFP. Gender is a social construct assumed to be aligned with sex at birth due to the young age group in this study. Neighborhoods

were considered to be the area around residence as defined by the included studies. Built environments included external features and functions of buildings, streets, open space, and infrastructure at various scales. We included urban or suburban and excluded rural study contexts, to focus on environments largely shaped by modifiable human activities and structures.

### Study Selection

Two authors independently screened titles and abstracts and reviewed full texts, following inclusion and exclusion criteria (Table 1) and using Covidence 2.0 systematic review software [25], resolving disparities through discussion. Following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines, the search and selection process is summarized in Fig. 1 [26].

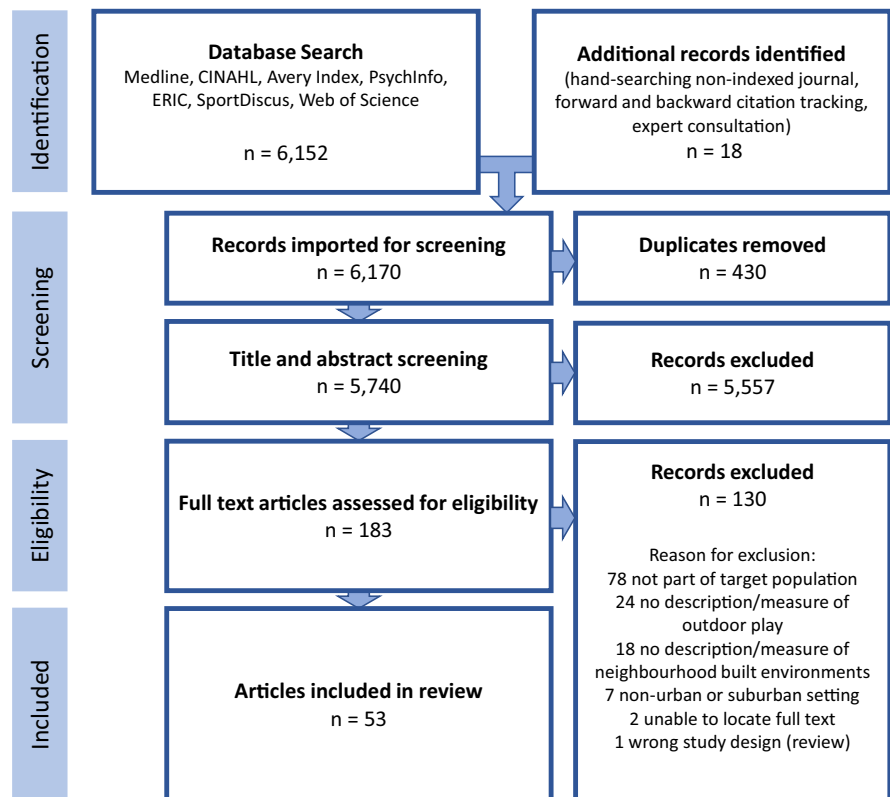
### Data Extraction and Quality Assessment

We developed and refined the data collection by piloting independent extraction of 5 papers by two reviewers, focusing on age group and outcomes relevant to the research questions (Supplementary File

**Table 1** Review search terms and inclusion and exclusion criteria

	Search terms	Include	Exclude
Population	Child Infant Toddler Preschool	Studies with children and/or parents/guardians of children, 0–6 years old	Studies when data cannot be isolated from broader age group or when limited to children with specific physical or behavioral conditions (with the exception of obesity or overweight)
Exposure	Built environment Physical environment Neighborhood Park Playground Street Yard Residence characteristics Public spaces	Studies with objective or subjective measures or descriptions of neighborhood outdoor built environment features and characteristics	Studies that focus on indoor environments
Outcome	Play Playing Unstructured time Leisure Hanging out Recreation	Studies that measure or describe children’s access to and/or use of neighborhood space for outdoor free play (including measures of physical activity in the context of outdoor free play)	Studies that measure or describe access to and/or participation in outdoor play/physical activity within the context of formal learning and structured environments, such as child care, school or other adult-directed programs
Setting		Studies conducted in urban or suburban settings	Studies conducted in rural settings

**Fig. 1** PRISMA flow diagram for article screening and selection



2). Subsequently, one reviewer extracted and a second reviewed all data, resolving discrepancies through discussion.

Two authors independently assessed the quality of included studies using the Mixed Methods Appraisal Tool (MMAT) [27] resolving differences through discussion. The MMAT assesses methodological quality of quantitative, qualitative, and mixed methods studies with demonstrated reliability and efficiency [28, 29]. Designation of low, medium, and high quality were based on a study meeting  $\leq 40\%$ , 60–80% or 100% of MMAT criteria, respectively (Supplementary File 1).

### Analysis and Synthesis

One author inductively coded study findings using NVIVO 12 software [30], transforming quantitative results by categorizing findings into qualitative codes [31, 32]. The second author independently coded every 5th paper to support validity of emergent themes. We aggregated inductive codes into descriptive themes [33], identifying convergence/divergence in findings across gender, culture, and geography and documenting

emerging secondary findings through memo-ing. Drawing on inductive codes and memos, we developed analytic themes within the framework of the research questions [33]. We considered quantitative studies for meta-analysis; however, this was not feasible due to heterogeneity of exposures and outcomes. We kept detailed notes throughout to provide a contemporaneous account of analytic and reflexive processes.

### Results

We assessed 5,740 non-duplicate studies and included 53, representing 24,792 parents, children, or parent/child dyads from 28 quantitative, 19 qualitative, and six mixed-methods studies. Studies were conducted in 17 countries: Australia, 13; USA, 10; Netherlands, 5; China, 4; New Zealand, 3; Canada, 3; South Africa, 2; Ireland, 2; UK, 2; one in each of Germany, Jordan, Malaysia, Portugal, Turkey, and Denmark; and three in multiple countries: Italy-Denmark-Poland, USA-Denmark, and Italy-Ireland. Quantitative studies were mostly cross-sectional, assessing associations

between parent-reported or objectively measured neighborhood characteristics and children's OFP, or reporting OFP frequency in different environments or with different affordances. Outcomes were frequency and/or duration of outdoor play, active play, parent-child coactivity, or physical activity (in the context of OFP). Qualitative studies explored parent and/or child perceptions of neighborhood influences on OFP. A majority of studies focused on the 2 to 6 age range; among studies that included children under 2 [34–39], only four reported findings for this group separately from older children [34, 35, 38, 39]. Thus, findings below apply to children between 2 and 6, unless otherwise specified.

Proportionate agreement was high for screening (title/abstract 0.95, full text 0.81) and inter-rater reliability fair for title/abstract and moderate for full-text review (Cohen's Kappa 0.34 and 0.58, respectively). Screening decisions were skewed toward exclusions, yielding a lower measure of inter-rater reliability (Cohen's Kappa) despite high agreement [40, 41]. We assessed 21 studies as high, 22 as medium, and 10 as low quality (Table 2). Assessment of low quality was most often due to insufficient detail in methods, high bias risk, or potential confounders missing from analysis. Quality of evidence for built environment influences on OFP is considered in Table 3.

### Thematic Synthesis

Three interconnected themes emerged from a synthesis of study findings. Features of *space for play*; *routes* and *social environments* intersected to influence availability, accessibility, and acceptability [42] of neighborhoods for young children's OFP. We organized results around these intersections, considering the convergence or divergence of findings across gender, cultural, and geographic contexts (Fig. 2). Evidence summary for built environment influences on OFP is given in Table 3.

#### *Availability of Neighborhood Outdoor Space for Play*

**Parks and Playgrounds** Close proximity of parks and playgrounds to home or daily destinations supported young children's OFP across contexts [24, 34, 43, 44–48]. Playgrounds were key motivators to active OFP among 4–6-year-old Malaysian children and park, or playground use was associated with OFP

in Ireland [49] while long distance to parks or playgrounds was a barrier in the UK, USA, Jordan, Italy, and Denmark [34, 48, 50–52]. New UK immigrants considered greenspace within a 20-min walk to be useable [34]. Canadian parents perceived parks and playgrounds to be neighborhood destinations most relevant to 3–4-year-olds' active play [53]. OFP mediated the relationship between nearby recreation facilities and preschoolers' PA in Tianjin, China [54], and parks visited by 3–5-year-olds were closer to home than those visited at older ages, despite being smaller and lacking the same amenities [24]. For some, parks provided the only outdoor space with room to run [46, 47]. However, for US children from low-income families, having a park within walking distance was not related to weekday OFP [55].

**Home Yards** Presence of a home yard was associated with  $\geq 2$  h of OFP in a US survey of parents with preschoolers in Head Start programs [55], and lack of a yard was cited as a reason for less play outdoors in Italy and Australia [44, 52]. Conversely, higher OFP among 4–6-year-old girls was seen with absence of private gardens in Dutch cities [56]. In the context of Covid-19 lockdowns in Italy and Ireland, garden/yard spaces were more important for OFP in 4–6-year-olds than older children [57].

**Informal Space** Fourteen studies directly included child perspectives [35, 37, 46, 51, 57–66]. Young children's conception of "play space" differed from that of adults; they viewed all spaces as potentially playable, engaging with their surroundings wherever possible [47, 51, 62, 67]. Children's perception of neighborhoods seemed to be relationally, rather than spatially, defined: their neighborhoods were those spaces around home where interactions with people, plants, animals, buildings, destinations, and routes were possible [62]. When accessible to them, children valued paths, streets, sidewalks, and open squares for play, with amenities such as bike racks, bushes, or puddles incorporated into OFP [47, 51, 62, 67]. In Jordan, children were drawn to streets, sidewalks, and house entrances as places to meet friends and watch people, enjoying being "...where the action is, where the life of the community takes place..." [51 p. 821]. For young children, characteristics of and interactions along routes could be as important as destinations [67].

**Table 2** Characteristics of included studies

Article	Country	Population, relevant age group, n <sup>c</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Aarts et al. [56]	Netherlands	Parents of primary school children in four cities. Children 4–6 years, n = 1248 <sup>a</sup>	Quantitative, cross-sectional, "...identify physical and social correlates of outdoor play in the home and neighborhood environment..."	Type of residence, presence/absence of garden, degree of unoccupied houses, trash/litter, dog waste, neighborhood type, degree of high, low-rise buildings, neighborhood greenness, presence of water, traffic situation, quality of sidewalks, bike lanes, diversity of routes, distance to facilities, satisfaction with play facilities, satisfaction with public space, greenspace. Family and community-level social variables	*****
Aarts et al. [72]	Netherlands	Parents of primary school children in four cities. Children 4–6 years, n = 2173 <sup>b</sup>	Quantitative, cross-sectional: "...identify quantitative as well as qualitative neighborhood characteristics related to outdoor play..."	Outdoor play, min/wk Residential density, land use mix, presence of unoccupied houses, maintenance of houses, number of formal OP facilities per km <sup>2</sup> , quality of formal OP facilities, presence, quality of greenspace, water, sidewalks, bike lanes, pedestrian crossings without lights, pedestrian crossings without lights, traffic lights, refuges/safety islands, parallel parking, parking lots, speed bumps, home zones, 30 km zones, roundabouts, intersections, traffic volume and speed; dog walking area; litter basket for dog waste; graffiti; vandalism; street lighting; presence of dark spaces; general impression Outdoor play, min/wk	*****

Table 2 (continued)

Article	Country	Population, relevant age group, <i>n</i> <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Abu-Ghazzeah [51]	Jordan	Residents of two streets in Abu-Nuseir. Preschoolers and mothers, <i>n</i> not specified	Mixed methods case study: "... to learn about the nature of children's activities in the streets of a residential community in Jordan."	Qualitative description of play location, elements used and perspectives of children and mothers. Descriptive statistics for neighborhood observations	**
Allport et al. [50]	UK	Somali immigrant mothers of preschoolers in Bristol. <i>n</i> = 6	Qualitative, interpretive phenomenology: "...to explore the geography of childhood from the perspective of Somali mothers who have resettled in Bristol."	Mother's experience of early childhood in Somalia and experiences of raising their young child in the UK	*****
Andrews et al. [67]	Australia	Parents of preschool children in inner and outer suburbs of Melbourne. 98 parents (quant phase), 20 (quan and qual phase). <i>N</i> = 98	Mixed methods: exploration of parents' experiences of their preschool aged children's play in inner and outer suburbs. With whom and where children played, reasons for any differences in play experiences	Residence in inner or outer suburb. Weekday, weekend time spent in unstructured play, location of play, with whom children played during unstructured play time	***
Armstrong et al. [89]	Australia	Children attending 104 randomly selected ECEC centers across metropolitan Perth, Western Australia and their parents. Children 2–5 years, <i>n</i> = 224	Quantitative, cross-sectional: to examine the relationship between features of the home yard space (vegetation, natural features, lawn presence, and quality) and preschoolers' outdoor play and objectively measured physical activity	Presence of natural features and play areas, fixed and portable play equipment, number, types of flowers, herbs and vegetables, lawn quality, area of front, back and/or other yard spaces or parent-estimated yard area Minutes of outdoor play in yard or street around residence (0, 1–15, 16–30, 31–60, > 60)	****

**Table 2** (continued)

Article	Country	Population, relevant age group, n <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Bassul et al. [49]	Ireland	English-speaking parents of 3–5-year-old children attending 25 preschools located in high, medium and low deprivation areas of Dublin. <i>n</i> = 276	Quantitative, cross-sectional: to examine the association between neighborhood deprivation index, parents' perceptions of their neighborhood environment, and healthy/unhealthy markers of child dietary intake, physical activity, and TV screen time	Neighborhood deprivation, parent perceptions of neighborhoods for walking, cycling: satisfaction with and use of physical activity facilities, satisfaction with food environment, satisfaction with neighborhoods as a place to live/raise a child Children's dietary intake, children's active play (< 1 h per day, > 1 h per day), children's structured activities (y/n) and TV screen time (< 1 h per day, > 1 h per day)	***
Beattie [66]	Canada	A single, 3–4 years old, female child. ( <i>n</i> = 1)	Qualitative, exploratory case study: a case study into one child's perspective on outdoor play	Qualitative description of child's experience and perspectives of outdoor play	****
Benwell [61]	South Africa	Children from suburban town in Cape Peninsula, majority from middle-upper-class backgrounds. Child, 6 years, <i>n</i> = 1 (qualitative data for one child in relevant age group)	Qualitative description: exploration of how children used and moved around outdoor space, and factors influencing outdoor engagements	Qualitative description of child use of outdoor space and factors influencing this use	**
Bourke and Sargisson [39]	New Zealand	All children using the playground during observations. Children 0–2, 3–5 years, <i>n</i> = 601	Quantitative descriptive, cross-sectional: to measure the frequency of play area and equipment use as a measure of children's play preferences	Play equipment and spaces with different characteristics (three areas of a single park/playground) Frequencies of use of different play areas between age groups, genders	****



Table 2 (continued)

Article	Country	Population, relevant age group, n <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Bulgarelli [57]	Ireland	Parents of a child, 4–6 years living in Italy or Ireland during 2020 Covid-19 lockdowns. n = 637	Mixed methods, content analysis, descriptive analysis: to describe children's outdoor activities and play, and contextual factors influencing them during the first 2020 Covid-19 lockdown and differences across disability, gender, country, and age groups	Parental description of children's outdoor activities during Covid-19 lockdowns: type of activity, context, people, objects	**
Caroli et al. [52]	Denmark, Italy, Poland	Children (3–6.5 years) from kindergartens in disadvantaged areas in Copenhagen (Denmark), Francavilla Fontana/Conversano (Italy) and Katowice (Poland). n = 1094	Quantitative, ecological, cross-sectional: to assess preschool children's physical activity habits in four cities in three different European countries	Country of residence Travel mode to kindergarten Outdoor play possible? If yes, where? Time spent playing outside home during weekdays and weekends: < 30 min, > 30 min, > 1 h Reason if child does not play outside?	**
Chen et al. [58, 60]	China	Parents with children who utilize the Guangzhou Children's Park. Children, 4–6 years, n = 8 (interviewees, unknown number observed)	Qualitative, case study: exploration of the experiences of children and their parents in Guangzhou Children's Park, Guangzhou City	Qualitative description of children's and parents' experience and perspectives of using the park	*****
Coci et al. [43]	Australia	Parents of 2–5-year-old children who attended long daycare and owned a dog, from low, middle and high SES areas in metropolitan Perth, Western Australia. n = 12	Qualitative: To investigate parents' perceptions of the barriers and motivators to their preschool child playing with the family dog and going on family dog walks	Qualitative thematic analysis of parent perspectives of barriers and motivators to preschoolers play and walking with the family dog	*****
Cronin-de-Chavez et al. [34]	UK	Parents of 0–3-year-old children in an urban, deprived, multi-cultural area in North England. n = 23	Qualitative description: "...to explore determinants [...] of urban greenspace use amongst a low income, multi-ethnic sample of parents with young children living in an area of high deprivation..."	Qualitative description of parent's experience of barriers and enablers to use of urban greenspace	*****

**Table 2** (continued)

Article	Country	Population, relevant age group, n <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
do Carmo et al. [74]	Portugal	Children and parents (3–11) from 119 public and private kindergartens and primary schools in mainland Portugal. Relev age group, 3–6 years, n = 3819	Quantitative, cross-sectional mediation analysis: to investigate the influence of parental perceived environment on PA, TV time, active play and BMI z score, and the mediating role of behaviors on the relationship between neighborhood characteristics and children's BMI	Parent perception of favorable or unsafe neighborhood environment Time in active play (play out) < 1, 1–2, 2–3, 3–4, > 4 h	**
Dwyer et al. [71]	Australia	Parents of children (3–5 years) from Middle Eastern (lower SES) and Chinese (higher SES) background. n = 22	Qualitative: to explore attitudes, values, knowledge and understanding of parents and carers of 3–5-year-old children about physical activity and small screen recreation and factors which influence these behaviors	Parent perspectives on factors that influence preschoolers' physical activity	*****
Ergler et al. [62]	New Zealand	Children from three preschools located in different geographic areas, neighborhoods, socioeconomic and ethnic groups. Children 3–5 years, n = 10	Qualitative: to provide insight into preschool children's "use of and experiences in their urban environments."	Preschool children's perspectives and experiential knowledge of urban neighborhoods and affordances	*****
F. Wang et al. [35]	China	Intergenerational parents of 0–6-year-old children from three residential quarters in Beijing. 198 questionnaires, 23 interviews. n = 198	Multi-methods with main focus on qualitative findings, cross-sectional: to investigate the use of outdoor space, demands of outdoor activities, preferences, behavioral patterns, attitudes and suggestions of preschoolers and inter-generational parents	Qualitative description of inter-generational parent perspectives on factors influencing space choice and use for outdoor play. Descriptive statistics of survey responses	**

Table 2 (continued)

Article	Country	Population, relevant age group, <i>n</i> <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Flowers et al. [24]	Australia	Parents of children 3–5 years old from preschools, long day care centers in metropolitan Melbourne. <i>n</i> = 353	Quantitative, exploratory, mixed models: to investigate features present in the parks that children visit at different ages	Features associated with park visitation: access, surrounding neighborhood, park size, road crossings, park facilities, affordances (e.g., toilets, lights, barbecues) Park visitation at 3–5 years, 6–8 years and 9–11 years	***
French et al. [70]	USA	Low-income, high BMI, 2–4-year-old children and their parents. <i>n</i> = 534	Quantitative, cross-sectional: to examine associations between child and parent physical activity, neighborhood characteristics and park use frequency among low-income parents and preschoolers	Parent perceptions of the neighborhood environment, parent support for child physical activity, moderate/vigorous physical activity and BMI percentile Parent and child park use frequency	*****
Goodway and Smith [64]	USA	Low income, racialized families with children (mean age 4.74) assessed as high risk for school failure and enrolled in compensatory prekindergarten programs. <i>n</i> = 59	Qualitative description: to examine the contextual factors influencing the physical activity of urban African American preschoolers	Parent and child perspectives on barriers and facilitators of preschoolers' physical activity	*****
Grigsby-Toussaint et al. [80]	USA	Socioeconomically and ethnically diverse children and parents from five counties in Central Illinois. Children 2–5 years, <i>n</i> = 365	Quantitative, cross-sectional: to examine whether residing in greener neighborhoods was associated with higher outdoor physical activity among preschoolers, and whether outdoor play behaviors (e.g., active vs. quiet) were influenced by levels of neighborhood greenness independent of demographic and parental support factors	Average NVDI for 30 × 30 m pixels in a 8100m <sup>2</sup> area around residence Minutes active OP on avg. weekday, weekend day; minutes of quiet OP on avg. weekday, weekend day, total minutes of OP	*****

Table 2 (continued)

Article	Country	Population, relevant age group, n <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Hayward et al. [87]	USA	Child users of study park (including preschool aged)	Mixed methods: "...what is the nature of children's play and the play/environment relationship in differently designed playgrounds?"	Qualitative description of behavior mapping, behavior records for preschoolers in different settings. Descriptive statistics for users of each playground type	*
Hinkley et al. [44]	Australia	Parents of 3–5-year-old children attending preschool in metropolitan Melbourne. n = 23	Qualitative: to examine parents' perceptions of the influences on their preschool-aged children's physical activity	Parent perceptions of influences on preschool-aged children's physical activity	*****
Hnatiuk et al. [45]	Australia	Parents of 2–4-year-old children living in the Western Sydney region. n = 15	Qualitative: to explore parents' perceptions about barriers and facilitators to physical activity and family-based co-participation in physical activity	Parent perceptions of physical activity co-participation for themselves and their child	*****
Hunter et al. [53]	Canada	Parent with a child, 3–4 years who resided in Edmonton, Canada. n = 145	Quantitative, cross-sectional: to identify neighborhood features perceived as relevant to preschoolers' active play, parents' active recreation, and their coactivity; to determine whether features considered relevant differed between activity domains and to determine whether relevant features differed by household income	Parental perception of relevance of destinations (parks, dog parks, playgrounds, schools, sports fields, courts, arenas/ice rinks, community hall, river valley/ravine), design (main roads, cul-de-sacs, quiet streets, block length, trails, sidewalks), social factors (friends/family, child's friends, other people walking/exercising, other children playing outside, knowing neighbors, trusting people in neighborhood), safety (street lighting, low crime, low vehicle traffic, daylight, sidewalk maintenance, pedestrian crosswalks), aesthetics (cleanliness, no graffiti, attractive houses, natural features, landscaped features) and child's active play, parent/child coactivity	**

Table 2 (continued)

Article	Country	Population, relevant age group, <i>n</i> <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Kabisch and Kraemer [36]	Germany	Visitors to two closely situated parks with different characteristics in Leipzig, during the 1-week study period, Children 0–6 years, <i>n</i> = 253 groups	Quantitative, descriptive, cross-sectional: to examine which park characteristics attract children and older people and whether users adapt their behaviors under conditions of summer heat?	Physical environments of two different parks including: size, vegetation, facilities and surrounding conditions Descriptive statistics on characteristics of two parks and user ages, observed places of activity during the 7 day observation period with temperatures ranging from < 25 to above 29.6 °C	****
Kimbro et al. [69]	USA	Sub-sample of birth cohort that, when weighted is, representative of all births in large US cities, 1998–1999. Children, 3–5 years, <i>n</i> = 1822	Quantitative, cross-sectional: to examine if outdoor play and television viewing are associated with 5-year-old's weight status and whether subjective and objective measures of residential contexts are associated with activity patterns	Residential context, neighborhood poverty, residential tenure, neighborhood collective efficacy, physical disorder, physical decay measures Hours of weekday outdoor play	*****
Klingberg et al. [75]	South Africa	Socio-economically diverse parents of 3–5-year-old children in Soweto. <i>n</i> = 16 parents	Qualitative: to describe how parents of pre-school-age view children's health behaviors and to situate these perspectives in the context of preschoolers' homes and wider environments	Parent perspectives on preschoolers' movement behaviors (including barriers and facilitators to physical activity and outdoor play behaviors)	*****
Lee et al. [78]	Malaysia	Stratified random sample of 4–6-year-old children from government private kindergartens in urban and rural areas of peninsular Malaysia, Sabah and Sarawak. Malay, Chinese, Indian and other groups, <i>n</i> = 835	Quantitative, cross sectional: to report the time spent on active play, quiet play, and in front of a screen by sociodemographic characteristics; to determine the main barriers, motivators, and environmental factors that influence preschoolers' participation in active play	Usual place for active play, barriers/motivators to active play. Time spent in active play, quiet play and screen time, (weighted averages over weekday and weekends)	***

**Table 2** (continued)

Article	Country	Population, relevant age group, n <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Lu et al. [54]	China	Children, (3–6 years) attending randomly selected preschools in three districts of Tianjin, China n = 1031	Quantitative, cross-sectional: to examine home and neighborhood environmental correlates of preschoolers' sedentary time and physical activity	Household income, primary caregiver, presence/absence of elevator, garden, care, number of televisions, computers in household, presence/absence of television, computer in child's room, mode of transport to school. Distance index score (represents walking distance from home to 6 PA facilities), scale of social support, scale of environmental quality in neighborhood Sedentary time, light and moderate-vigorous physical activity by accelerometry and parent report. Outdoor play (minutes/week) as a mediator of the relationship between "distance index" and light physical activity	****
Lynch et al. [46]	Ireland	Children and accompanying adults at five park or playground sites in an urban municipality in Ireland. Children 3–6 years, n = 5	Qualitative, case study: to investigate child and adult perspectives on accessing and participating in play in public parks and playgrounds; and to explore the experiences of local council park and playground providers on the design and provision of inclusive public parks and playgrounds	Play audit of parks to assess play value and accessibility. Walk and talk audit to determine actualized playability and usability with parent-child dyads. Onsite play preferences, play choices and barriers, and enablers for play, parent and child perceptions and use of parks	****

Table 2 (continued)

Article	Country	Population, relevant age group, <i>n</i> <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Marino et al. [55]	USA	Representative sample of children (3–4 years) entering Head Start (fall, 2006) using 4-stage clustered, stratified sampling. <i>n</i> = 2529	Quantitative, cross-sectional: to estimate the amount of time low-income US preschool-age children spend playing outdoors at home and at school; to identify relationships between outdoor play, socio-demographics and weight status; and to assess the extent to which children's environments at home and school are associated with outdoor play	Presence of yard Presence of park or playground within walking distance Picnic, park, playground visit with child in past month Parent-reported typical weekday time spent playing outdoors at home (< 1, 1–2, > 2 h) and at school	***
Mart et al. [65]	Turkey	Syrian refugee children (4–6 years old) living in Turkey in Konya or Kilis city centers or refugee camps. <i>n</i> = 46	Qualitative, arts-based: to understand Syrian refugee children's perceptions about playgrounds	Qualitative arts-based content analysis of children's drawings of playgrounds	****
McGlone [63]	Australia	Children and adult users of a Pop-Up Park in an inner suburb of Melbourne. Children 5–6 years, <i>n</i> not specified	Qualitative, case study, mosaic approach: to explore children's views and opinions, how the temporary, interactive nature of the Pop-Up Park influences its use and whether the Pop-Up Park supports or inhibits children's need for play and connection to the wider community?	Qualitative description of children's experience and perspectives of pop-up park	*****
Oakley et al. [81]	Australia	Children and caregivers participating in Wave 3 (child age 6 years) of longitudinal HealthNuts study in Melbourne, Australia. <i>N</i> = 1648	Quantitative, cross-sectional: to investigate the relationship of objectively measured yard size and yard greenness with children's (1) objectively measured physical activity and (2) parent reported outdoor play time	Yard size (area of land parcel — area of building footprint), yard greenness (median annual Normalized Difference Vegetation Index) Parent-reported outdoor play outside of school hours for weekends and weekdays	***

**Table 2** (continued)

Article	Country	Population, relevant age group, <i>n</i> <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Penilla et al. [77]	USA	Parents of 2–5-year-old children in San Francisco, of Mexican, Guatemalan or Salvadoran descent, <i>n</i> = 49	Qualitative: to examine parents' perceived environmental obstacles to preventing obesity and the influence of these obstacles on children's eating and physical activity	Parent perspective of barriers to healthy child weight, including barriers to outdoor play	*****
Phillips [47]	Canada	Parents in a Vancouver neighborhood with at least one 2–5-year-old child. <i>n</i> = 9	Qualitative: to understand parent perspectives of neighborhood outdoor play spaces	Qualitative description of parent perspectives of neighborhood outdoor play spaces	*****
Q. Wang et al. [73]	China	Parents of 3–6-year-old children from 5 kindergartens in Shenyang and 5 kindergartens in Anshan. <i>n</i> = 1772	Quantitative, cross-sectional: to investigate regional differences in outdoor playtime and screen-viewing time and their relationship with environmental factors and to identify modifiable determinants in differences between urban and rural areas	Physical environment: access to shops, public transportation, presence of sidewalks and bicycle lanes, access to exercise facilities, crime safety, traffic safety, social environment, aesthetics, number of motor vehicles in household Parent-reported average outdoor play time on weekdays and weekends in past month (minutes: 0, 1–15, 16–30, 31–60, ≥ 61)	**
Refsauge et al. [48]	USA and Denmark	Adults accompanying children in study playgrounds in Cary, North Carolina, USA and Copenhagen, Denmark. Average child age 4.4 in Denmark, 4.3 in USA. <i>n</i> = 261 adults	Quantitative, cross-sectional: to examine differences between countries in: characteristics of adults accompanying children to parks; frequency and duration of park use; users' motivations and choice of playgrounds; characteristics of playground trips, users' likes, dislikes and connections between these and physical layout and location of playgrounds	Factors from factor analysis of multiple features: social factors, nearby green, distance and accessibility, nationality, design/variety dislike Frequency (number of visits per week: once a week or more, infrequently) and duration (on weekends: 0–60 min, > 60 min) of park visits. Qualitative quotes also given to illustrate parent perspectives	****



Table 2 (continued)

Article	Country	Population, relevant age group, <i>n</i> <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Refshaug et al. [37]	Denmark	Child and adult users of park in suburban Copenhagen. Children 0–5 years, <i>n</i> = 158 (questionnaire 51, behavior mapping 107)	Qualitative, case study, post-occupancy evaluation: "How does the actual use of the design correlate with the evidence-based design intentions?" (study questions relevant to review)	Different areas and affordances in park: open space, play structure, sand play, swing sub-settings. Type of behavior and play (functional, dramatic, constructive and games) in different areas of playground. Qualitative description of questionnaire and observation results	***
Remmers et al. [79]	Netherlands	Children (5–6 years) participating in cluster RCT and who attended checkups at "control" Youth Health Care team in participating clinics. <i>n</i> = 2007	Quantitative, longitudinal and cross-sectional: examined whether the family environment and perceived physical environment are associated with the duration of children's outdoor play behavior	Relevant to review: Traffic, perception of daytime safety, perception of evening safety, presence of sidewalks, child-friendliness of neighborhood, attractiveness of neighborhood for families with children, opportunities for OP, safety of outdoor play without supervision	**
Sallis et al. [86]	USA	Children (4–5 years) attending San Diego County preschools, children's centers, Head Starts and private preschools and participating in larger longitudinal study. <i>n</i> = 300	Quantitative, exploratory study using longitudinal cohort data: examined factors parents used in selection of play spaces for their preschool children. Investigated changes over time in the importance of decision factors and whether the importance of such decision factors varies by ethnicity	Parent-reported total duration of unstructured OP in average week (excludes organized sports, school PE, active transport) Descriptive statistics: average rating of 24 decision factors influencing play-space selection. Differences across Mexican-American and White parents' ratings and changes of ratings over time	***

**Table 2** (continued)

Article	Country	Population, relevant age group, <i>n</i> <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Sargisson [38]	New Zealand	Children visiting one of 56 playgrounds in 44 population centers on the North Island of New Zealand. Relevant age groups, 0–1, 2–3, 4–5. <i>n</i> not given	Quantitative, cross-sectional: to investigate how much, and in what ways children use natural elements in public playgrounds when available. To investigate children's preferences for built-play equipment or natural elements	Description of playground natural features (mown grass, trees, bark/sand/gravel, large rocks, garden beds, forest, shrubs, river/creek, beach, long grass, water (fountains, paddling pools, lake, hedge, harbor, scrub). Proportion of children's play with natural vs. all features (by age and gender)	***
Spurrier et al. [84]	Australia	Children (2 years) attending preschool in metropolitan Adelaide. <i>n</i> = 280	Quantitative, cross-sectional: to examine associations between maternal parenting style, self-efficacy, perceived environmental safety and behaviors and children's outdoor play and screen time at 2 years	Maternal self-efficacy, parenting style, perception of neighborhood environment: neighborhood safety, park/play space quality, safety for outdoor play, maternal PA and screen time, child screen guidelines and screens during mealtime	***
Stanton-Chapman and Schmidt [90]	USA	Children (4 years) attending pre-kindergarten with a playground and living within a 15 min drive of a community playground in a large, Midwestern, US city. <i>n</i> = 6	Mixed methods, descriptive case study: to develop an in-depth understanding of (1) children's social play behaviors on school and community playgrounds, (2) the duration with which children play within varying social play categories, and (3) assessing children's perspectives of playground activities, their peer relationships and recommendations for new playgrounds	Quantitative description of the duration of time children spent in each type of play (unoccupied, solitary, onlooker, parallel, associative and cooperative play) on school vs. community playground. Qualitative description of children's perspectives on social and physical aspects of playgrounds and ideas for future playgrounds	***

Table 2 (continued)

Article	Country	Population, relevant age group, <i>n</i> <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Stut [83]	Netherlands	Children (2–18) who live or participate in outdoor play in two districts in western Netherlands. (relevant age group, children 2–6 years) <i>n</i> = 81	Quantitative descriptive, cross-sectional: to describe use of neighborhood space for outdoor play by children in two districts in Amsterdam Nieuw-West, determine which type of playgrounds are best used and investigate the demographic characteristics of local residents	Informal or formal play area, old or new formal play area, size of play area (in m <sup>2</sup> ), public space in district (i.e. all formal and informal play areas), local population of same aged residents within 50 AND 100 m buffers of formal play areas Non-active and active play (based on observation, considering age, gender and time of observation) Play density (outdoor play population per 100m2)	***
van der Schaaf [88]	Netherlands	Children (5–6 years) from an elementary school, parents from a different elementary school. <i>n</i> = 16 children	Quantitative, cross-sectional: to determine the degree to which playground elements have an open function and to examine whether children are attracted to the elements with a higher degree of open function	Play equipment with higher and lower degrees of “open function” Frequency and duration of use of playground features	***
Ward [82]	Australia	Children (3–5 years) from early childhood education centers and primary school classes. <i>n</i> = 36	Qualitative, arts-based methods: to conduct community and participatory research with children, contributing plans for redevelopment of a community play space	Thematic analysis of child drawings to understand child perspectives, values and preferences with regards to play spaces	*****
Westley [76]	USA	Respondents to the Kansas City neighborhood and Park Study, who had 3–5 year-old child and lived in a census block within 0.5 miles of a study park. <i>n</i> = 23	Quantitative, cross-sectional: to examine associations between parents' perceptions of neighborhood safety and overall child PA, active commuting to school, park use, active transportation to parks, and sedentary behavior and how these relationships vary by child gender and age and household income	Parental perception of neighborhood safety. Child park use, child active travel to parks	***

**Table 2** (continued)

Article	Country	Population, relevant age group, n <sup>e</sup>	Study design and aim	Relevant exposure(s) and outcome(s) or qualitative description	Study quality
Xu et al. [91]	Australia	Mothers with children (2 years) participating in larger RCT, socio-economically disadvantaged areas of Southwestern Sydney. 497 mother/child dyads <sup>a</sup>	Quantitative, cross-sectional: to investigate if parenting style, parental self-efficacy, mothers' perceived environmental safety and mothers' behaviors are associated with children's outdoor play and screen time	Parental self-efficacy, parenting style. Mother's perceived neighborhood environment: neighborhood safety, park/play space quality, safety for outdoor play, mother's PA and screen time, child screen guidelines and screens during mealtime. Parent-reported time in outdoor play on a typical weekday, weekend day (< 2 h, > 2 h)	****
Xu et al. [68]	Australia	First-time mothers of children (2 and 3.5 years) from relatively socio-economically disadvantaged areas of South-western Sydney, participating in larger RCT. n = 912 mother/child dyads <sup>b</sup>	Quantitative, cross-sectional: to investigate whether mothers' perceived neighborhood environmental factors, type of accommodation, number of vehicles in a household, walkability, and population density are associated with children's outdoor playtime	Neighborhood environment factors: mothers' general perception of the neighborhood environment, perceived safety, park quality, safety for play, traffic conditions, type of accommodation, number of vehicles, suburb-level walkability, and population density at 2 and 3.5 years, respectively. Parent-reported time in outdoor play on a typical weekday, weekend day (< 2 h, > 2 h)	****

\*\*\*\*\* 100%, \*\*\*\*80%, \*\*\*60%, \*\*40% of MMAT quality criteria met

- <sup>a</sup>This sample is also analyzed in Aarts (2012)
- <sup>b</sup>A portion of this sample is also analyzed in Aarts (2010)
- <sup>c</sup>This sample is also analyzed in Xu (2017)
- <sup>d</sup>A portion of this sample is also analyzed in Xu (2014)
- <sup>e</sup>Analytic sample for relevant age group

**Table 3** Evidence summary for neighborhood built environment features and outdoor free play of young children

Positive built environment associations, facilitators, or motivators	Child age	Evidence type and quality			Negative built environment associations or barriers	Child age	Evidence type and quality		
		Quan	Qual	MM			Quan	Qual	MM
<b>Park close to home</b>				<b>Absence of a park</b>					
Cronin-de-Chavez [34]	0–3		*****		Allport [50]	preschool		*****	
Flowers [24]	3–5	***			Caroli [52]	3–6.5	**		
Refshauge [48]	4 (mean)	****			<b>Park too far away</b>				
Phillips [47]	2–5		*****		Abu-Ghazze [51]	preschool			**
Coci [43]	2–5	*****			Cronin-de-Chavez,2019 [34]	0–3		*****	
Hunter [53]	3–4	**			Refshauge [48]	4 (mean)	****		
<b>Physical activity facilities</b>									
Lu [54]	3–6	****							
Bassul [49]	3–5	***							
Hunter et al [53]	3–4	**							
<b>Presence of a playground</b>									
S. T. Lee [78]	4–6	***							
Hunter [53]	3–4	**							
<b>Presence of a yard/garden</b>				<b>Yards isolating, boring</b>					
Hinkley et al. [44]	3–5		*****		Benwell [61]	6		**	
Marino [55]	3–4	***							
Bulgarelli [57]	4–6			***					
Hunter [53]	3–4	**							
<b>Absence of a garden</b>									
Aarts [56] (for girls)	4–6	*****							
<b>Yard size (larger)</b>									
Oakley [81]	6	***							
<b>Yard play equipment, fixed</b>									
Armstrong [89]	2–5	****							
Benwell [61]	6		**						
<b>Streets, informal, temporary play space</b>									
Ergler [62]	3–5		*****						
McGlone [63]	5–6		*****						
Abu-Ghazze [51]	Preschool			**					
Phillips,2016 [47]	2–5		*****						
<b>Neighborhood cleanliness</b>				<b>Neighborhood disorder, vandalism</b>					
Hunter [53]	3–4	**			Goodway and Smith [64]	preschool	*****		
<b>No graffiti</b>									
Hunter [53]	3–4	**			Benwell [61]	6		**	
<b>Neighborhood disorder (physical disorder, incivilities)</b>									
Kimbrow [69]	3–5	*****							
French [70]	2–4	****							
Aarts [56]	4–6	*****							

**Neighborhood Design and Housing Type** Neighborhood design and housing type influence the

amount and type of outdoor space available. In Vancouver, Canada, limited private outdoor space

**Table 3** (continued)

Positive built environment associations, facilitators, or motivators	Child age	Evidence type and quality			Negative built environment associations or barriers	Child age	Evidence type and quality		
		Quan	Qual	MM			Quan	Qual	MM
<b>Perception of outdoor play as safe, general perception of good neighborhood to bring up child</b>									
Xu [91]	2	****							
Xu [68]	2, 3.5	****							
Westley [76]	3–5	***							
<b>Perception of safe parks or playgrounds</b>					<b>Park equipment broken, poor maintenance, litter, hygiene issues</b>				
Klingberg [75]	3–5	*****			Benwell [61]	6	**		
Xu [91]	2	****			Cronin-de-Chavez,2019 [34]	0–3	*****		
Refshauge [48]	4 (mean)	****			Penilla [77]	2–5	*****		
<b>Greenspace (higher NDVI, percentage of trees, vegetation)</b>					<b>Lack of greenspace (grass and shade)</b>				
Grigsby-Toussaint [80]	2–5	*****			Hnatiuk [45]	2–4	*****		
Kabisch and Kraemer [36]	0–6	****							
<b>Space to move independently, space to run</b>									
Cronin-de-Chavez [34]	0–3	*****							
Hnatiuk [45]	2–4	*****							
Lynch [46]	3–6	*****							
Refshauge [37]	0–5	***							
<b>Quiet space (absence of noise)</b>									
Refshauge [48]	4 (mean)	****							
Phillips [47]	2–5	*****							
<b>Natural environments and play materials (leaves, trees, sticks, flowers, sand, water, river, ravine)</b>									
Aarts [56]	4–6	*****							
Chen [58]	4–6	*****							
Cronin-de-Chavez [34]	0–3	*****							
Benwell [61]	6	**							
Ergler [62]	3–5	*****							
Lynch [46]	3–6	*****							
Refshauge [48]	4 (mean)	****							
Refshauge [37]	0–5	***							
Lynch [46]	3–6	*****							
Ward [82]	3–5	*****							
Mart [65]	4–6	*****							
Hunter [53]	3–4	**							
<b>Presence of animals</b>									
Mart [65]	4–6	*****							
Chen [58]	4–6	*****							
Cronin-de-Chavez [34]	0–3	*****							
McGlone [63]	5–6	*****							
Ward [82]	3–5	*****							
F. Wang [35]	0–6						**		

**Table 3** (continued)

Positive built environment associations, facilitators, or motivators	Child age	Evidence type and quality			Negative built environment associations or barriers	Child age	Evidence type and quality		
		Quan	Qual	MM			Quan	Qual	MM
<b>Park equipment variety, affordances for play at heights, with speed, physical challenge</b>				<b>Lack of play equipment variety, perception of park as boring, lack of infant, toddler play equipment</b>					
Beattie [66]	3–4		****		Refshauge [48]	4 (mean)		****	
Ergler [62]	3–5		*****		Hinkley [44]	3–5		****	
Lynch [46]	3–6		*****		Cronin-de-Chavez [34]	0–3		*****	
McGlone [63]	5–6		*****		Refshauge [48]	4 (mean)		*****	
Phillips [47]	2–5		*****		Phillips [47]	2–5		****	
van der Schaaf [88]	5–6	***			Refshauge [37]	0–5		***	
Mart [65]	4–6		*****		Refshauge [48]	4 (mean)		****	
<b>Park facilities: availability of toilets, drinking water, seating, bike racks</b>									
Sallis [86]	4–5	***							
Phillips [47]	2–5		*****						
Hinkley (seating) [44]	3–5		*****						
McGlone (seating) [63]	5–6		*****						
F. Wang [35] (seating)	0–6			**					
<b>Shade and rain shelter</b>				<b>Lack of shade, hot temperatures</b>					
Refshauge [37]	0–5		***		Chen [58]	4–6		*****	
Phillips [47]	2–5		*****		Hnatiuk [45]	2–4		*****	
Hnatiuk [45]	2–4		*****		F. Wang [35]	0–6			**
Kabisch and Kraemer [36]	0–6	****			Kabisch and Kraemer [36]	0–6		****	
Sallis [86]	4–5	***							
F. Wang [35]	0–6			**					
Hinkley [44]	3–5		*****						
Coci [43]	2–5		*****						
<b>Daylight</b>				<b>Wet, cold weather, wind, short days</b>					
Hunter [53]	3–4	**			Cronin-de-Chavez [34]	0–3		*****	
					Hinkley [44]	3–5		*****	
					Kimbro [69]	3–5		*****	
					F. Wang [35]	0–6			**
<b>Low traffic streets</b>				<b>High traffic streets</b>					
Hunter [53]	3–4	**			Andrews [67]	preschool			***
					Benwell [61]	6		**	
					Dwyer [71]	3–5		*****	
<b>Presence of roundabouts</b>									
Aarts [72]	4–6	*****			French [70]	2–4		****	
					Caroli [52]	3–6.5		**	
<b>Presence of sidewalks</b>									
Aarts [72]	4–6	*****			Cronin-de-Chavez [34]	0–3		*****	
Q. Wang [73]	3–6	**			Abu-Ghazze [51]	preschool			**
Hunter [53]	3–4	**			Aarts [72]	4–6		*****	
					Bassul [49]	3–5		***	
<b>Cycling, walking paths, trails</b>				<b>Bike lanes on busy streets</b>					
Q. Wang [73]	3–6	**			Bassul [49]	3–5		***	
Hunter [53]	3–4	**			Hinkley [44]	3–5		*****	

**Table 3** (continued)

Positive built environment associations, facilitators, or motivators	Child age	Evidence type and quality			Negative built environment associations or barriers	Child age	Evidence type and quality		
		Quan	Qual	MM			Quan	Qual	MM
<b>Fewer road crossings</b>				<b>Boring walking route, lack of green</b>					
Flowers [24]	3–5	***			F. Wang [35]	0–6			**
<b>Pedestrian crosswalks</b>				<b>Presence of intersections</b>					
Aarts [72]	4–6	*****			Aarts [72]				*****
Hunter [53]	3–4	**			<b>Street lighting</b>				
<b>Street lighting</b>				Aarts [72] (for boys)					
Hunter [53]	3–4	**			Aarts [72] (for boys)	4–6			*****
<b>Transit stop near home</b>									
Q. Wang [73]	3–6	**							
do Carmo [74]	3–6	**							
<b>Walkability<sup>a</sup></b>									
French [70]	2–4	****							
Hnatiuk [45]	2–4		*****						
Lynch [46]	3–6		*****						
<b>Home zones, enclosed street design</b>									
Aarts [72]	4–6	*****							
Andrews [67]	Preschool			***					
<b>Public housing</b>				<b>Flat or apartment</b>					
Kimbro [69]	3–5	*****			Aarts [56] (for girls)	4–6			*****
				Kimbro [69]					
				3–5					
				*****					
<b>Semi-detached/ duplex or rental</b>				<b>Duplex, townhome, rowhouse</b>					
Aarts [56] (for boys)	4–6	*****			Kimbro [69]	3–5			*****
				Aarts [56] (for girls)					
				4–6					
				*****					
<b>Residential proximity to other children</b>				<b>Limited proximity to other children, solitary streets</b>					
Andrews [67]	preschool			***	Andrews [67]	preschool			***
				Caroli [52]					
				3–6.5					
				**					

\*\*\*\*\* 100%, \*\*\*\*80%, \*\*\*60%, \*\*40% of MMAT quality criteria met

<sup>a</sup>Definitions of walkability varied across studies; see full description in “Results” section

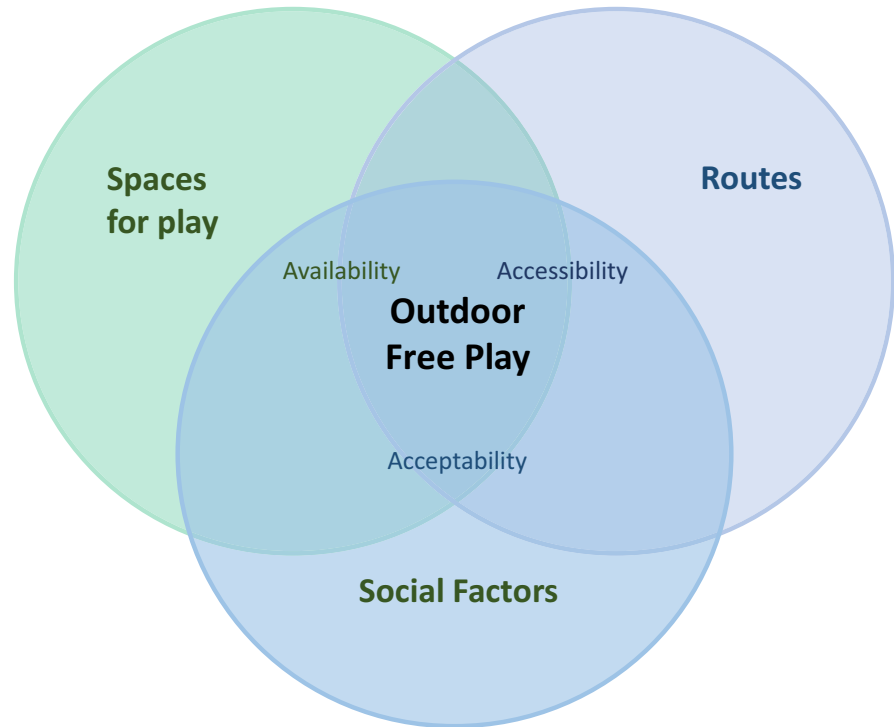
increased demand for public outdoor spaces [47]. Children in a higher-density Australian suburb (closer to city center) utilized parks or playgrounds, while those in lower-density, outer suburbs usually played in home yards [67]. In US settings, proximity of park was less important than in Denmark, where denser, more connected neighborhoods are common [48], and home yard but not distance to park or playground was associated with OFP [55].

Associations between housing type and OFP were largely inconsistent across the studies reviewed. In an Australian city, free-standing homes were associated

with more OFP [68], but linked to less OFP among young girls in Dutch cities [56]. Duplex, townhome, or rowhomes were associated with lower OFP compared to single-family homes in the USA while semi-detached, duplex, or rental properties were associated with more OFP among 4–6-year-old boys in Dutch cities [56]. Kimbro et al. [69] found that US preschoolers in public housing played outdoors more than those in non-public housing. Residence in apartments or high rises in Dutch and US contexts was associated with less OFP [56, 69] and cited as a barrier among low-income immigrants in the UK [34]; however, the



**Fig. 2** Availability, accessibility, and acceptability of neighborhood space for play



degree of high- vs. low-rise neighborhood buildings was not related to OFP in Dutch cities [56].

*Accessibility: the Interaction between Routes, Social Environment, and Space for Play*

**Routes to Spaces for Play** Use of parks, playgrounds, and greenspaces was determined not only by presence of these spaces in the neighborhood, but also by the characteristics of routes and surroundings. Not surprisingly, high-traffic streets were the most common physical environment barrier to OFP across contexts [34, 35, 43, 47, 51, 52, 56, 61, 67, 70, 71]. Pedestrian infrastructure including sidewalks, bike, and walking paths were associated with more OFP in some [43, 70, 72, 73], though not all studies [56, 74]. Parent perception of unsafe walking or cycling due to high traffic was associated with less OFP [49], and bike tracks next to busy roads were cited as barriers [44]. Parents considered sidewalks, trails, and quiet streets as neighborhood factors with most relevance to OFP in 3–4-year-olds (over main roads, cul-de-sacs, and block length) [53]. Having to cross

a street to access parks resulted in lower park visitation [48, 70], and preschool-age children visited parks with fewer adjacent road-crossing signals compared to older children [24].

Measures of walkability varied in content and scale across studies. Sidewalks, pedestrian crossings, markings, traffic control signals, or stop signs in residential block were associated with frequent park use [24], and greenspaces on the way to destinations such as child care, school, or shops facilitated OFP [45–47]. However, nearby shops were not significantly associated with OFP in another study, after adjustment for individual and socio-cultural factors [73], and suburb-level walkability based on distance to local amenities showed no significant relationship with OFP at 2 and 3.5 years [68].

**Social Influences on Access to Play Space** The neighborhood social and historical context influenced OFP: in South Africa, Benwell [61] and Klingberg et al. [75] describe how systemic inequities shape social context, influencing parental perceptions of safety, fear of crime, and trust in neighbors. In a low-income, racialized community in the USA, no

OFP was allowed at all because of fears of violence, crime, or hazards related to needles and other debris, despite availability of yard space [64]; conversely, higher parental safety perception was associated with park use among 3–5-year-olds [76]. Immigrant status could also influence children's access to play. Unfamiliarity with public greenspace locations and bus routes and fear of trespassing limited new UK immigrants' greenspace use [34], while some US newcomers avoided social connections due to undocumented status and fear of deportation [77]. Not knowing neighbors was a barrier, while trusting neighbors, social connections, social cohesion, and collective efficacy supported OFP across contexts [34, 50, 52–54, 61, 67, 69, 71, 77, 78].

Family context strongly influenced children's OFP: Remmers et al. [79] found that family characteristics, but not parental perceptions of the physical environment, predicted child OFP. In China, caregivers were often grandparents, whose physical tiredness, heightened sense of responsibility, and safety concerns could limit children's OFP [35]. Family context interacted with physical environments: lack of nearby space for OFP and social connection compounded stress from financial insecurity, minority group membership, and separation from familiar culture, language, and family among new immigrants [34, 50, 77]. Because young children's OFP usually requires adult accompaniment, long work days, parental exhaustion, mental health issues, or preoccupation with financial survival could limit OFP [34, 44, 58, 77].

#### *Acceptability: Parent and Child Perceptions of Neighborhood Space for Outdoor Play*

**Green and Natural Space for Play** Higher neighborhood greenness (assessed using Normalized Difference Vegetation Index, NDVI) was associated with more quiet and active OFP in five US counties [80]. However, in green, affluent Australian neighborhoods, no association between yard greenness (NDVI) and OFP was found [81]. Park use was higher in areas with more trees and greenspace [36], while lack of greenspace was a barrier to child and parent outdoor physical activity [45]. Across contexts, young children were attracted to natural environments; trees, flowers, leaves, sand, sticks, and natural

play materials were motivators to OFP [34, 37, 46, 48, 58, 62]. Trees were the most common natural object in playground drawings by Syrian refugee children [65]. Interaction with nature, even in small, informal areas such as planters [63] or traffic roundabouts [47] were highly valued, and children were fascinated by animals: ducks, squirrels, dogs, birds, and insects [34, 58, 63, 65, 82]. Though parents and children sometimes had safety concerns about dogs [62, 67], presence of dog waste was associated with more OFP among 4–6-year-old girls [56].

**Quality and Affordances of Space for Play** Outdoor spaces that met the needs of both parents and children facilitated OFP. Pleasant, quiet, natural spaces and presence of other adults with children could support parents' own physical, social, and mental health, decreasing parental stress and isolation while supporting children's OFP [34, 44, 47, 48].

Nearby traffic posed safety concerns and limited yard or park use [44, 45, 49]. Fencing increased perception of play space safety [45, 47, 63] but was sometimes less esthetically pleasing [37]. Park size was unrelated to observed number of preschoolers [83], and park proximity, but not size or amenities, was associated with preschoolers' park use [24]. For families with dogs, larger yard size could facilitate or decrease preschoolers' OFP, providing play space or decreasing motivation for dog walking [43]. However, Spurrier [84] found no relationship between yard size and OFP after adjusting for other features while Oakley [81] found minimal (0.4 min/day) increases in OFP with each 10% increase in yard size.

Parents and caregivers across contexts were concerned about shade, seating, facilities (e.g., toilets, drinking water), safety, cleanliness, and overcrowding of play spaces [34–37, 43, 44, 47, 48, 58, 77, 85, 86]. Lack of variety in play equipment or perception that a play space was boring could limit OFP [44]. Inadequate play equipment for infants and children under two was a recurring issue [34, 37, 47, 48]. Destinations with affordances for both dogs and preschoolers supported OFP in an Australian context [43]. Preschool children were attracted to places that afforded physical challenge, play at heights, and with speed (e.g., trees, slides, swings, climbing structures) [46, 47, 62, 63, 65, 66, 87, 88]. More play equipment in home yards was associated with more OFP [84, 89],

but even with extensive play equipment, yards could be perceived by children as isolating or boring [61].

Neighborhood disorder, unoccupied homes, poor building conditions, and presence of trash were generally associated with more OFP [56, 69, 70]. In Ireland, higher neighborhood deprivation was associated with lower participation in structured activities but not active play [49]. In Vancouver, Canada, dangerous litter (e.g., needles), but not graffiti, was perceived negatively; however, parents in Edmonton, Canada, considered neighborhood cleanliness and no graffiti to support OFP [47, 53]. In a US city, presence of trash, graffiti and vandalism enforced perceptions of social danger, prompting parents to limit OFP [64].

**Opportunity for Social Interaction** Across contexts, parents and children emphasized that opportunity for neighborhood social interactions supported OFP [44, 45, 47, 51, 53, 57, 58, 61, 63, 66, 67, 90]. Built environment features such as quiet streets [45], enclosed street designs (no through traffic) [67], home zones (traffic-calmed, residential street shared by pedestrians and vehicles) [72], temporary play spaces [63], and interesting routes [62, 67] created safe, inviting space for meeting neighbors, and the presence of children in these spaces could increase perceptions of social safety [47]. During Covid-19 lockdowns, 4–6-year-olds expressed more concern about inability to meet friends outside than did older children [57]. Public space for play with non-related children was important to many children in China because of social policies encouraging smaller families [58] and for single-child families in Canada [47]. Parks also provided space for family togetherness [58, 90]. A 6-year-old expressed:

My father works in a company in another city to make money. My mother stays alone in Guangzhou to take care of me. Only at the weekend, when we get together in the park, can I feel real happiness... [51, p. 469].

Qualitative evidence consistently emphasized the importance of other children to OFP [45, 51, 53, 61, 65, 67, 71, 90]. Preschoolers' ideas for future playgrounds revolved around increasing opportunities for play with friends [90]. In a lower-density suburb, parents identified a lack of nearby children as a barrier [67]; however, quantitative measures of density showed no clear relationship with OFP: same-age residential density was not associated with play density (children per 100 m<sup>2</sup>) [83]. Residential density

(based on occurrence of housing types) and suburb-level residential density (persons per hectare) showed no association with OFP [68, 72]. Though presence of other children generally supported OFP, parental perception that a play space was overcrowded could negatively impact use [34, 47, 58].

#### *Built Environments and Outdoor Play across Cultures, Geographies, and Gender*

**Cultural and Geographic Differences** Major built environment facilitators of OFP: presence of outdoor space to play, natural environments, and safe routes were consistent across ethnic and cultural groups. However, some specific features (e.g., dog parks) were relevant only in some contexts due to societal norms [43], and physical disorder was an inconsistent marker of social danger across contexts [47, 64]. Additionally, variation was seen in parental values, priorities, and preferences: connection with nature was highly rated by Dutch parents, while opportunity for physical activity was more important for Americans [48]. Mexican–American parents valued park facilities, affordances, and activities while White Americans rated safety, proximity, cost, uncrowded space, and friends higher, highlighting the importance of understanding the priorities of local users [86]. Middle Eastern families in Australia described prioritizing academics as a barrier to OFP, and parental emphasis on academics was linked to less outdoor playtime in a large Chinese city [71, 73]. Some Chinese parents in Australia considered being overprotective to be a cultural trait and made conscious efforts to prioritize active play [71]. Chinese parents in Malaysia expressed less worry about child safety than did Malay parents; however, their children played mostly within house compounds while Malay children played mostly in public parks [78]. In a large, Midwestern US city, though children strongly desired play with friends, play with unknown children was not allowed or preferred [90]. In contrast, at a park in Guangzhou, China, children readily made new friends, played cooperatively, and made plans for future play [58].

Cold, wet, and windy weather or short days in northern latitudes limited OFP [34, 35, 44, 69], while heat and/or shade were concerns across diverse

geographies, particularly for parents with infants and toddlers [36, 44, 47, 48, 58, 86].

**Gender Differences** We did not find consistent differences in built environment influences on OFP across genders. However, studies that examined gender differences in OFP generally found that boys played outdoors more, or more actively, than girls [44, 56, 72, 73, 78, 80, 91]. Heterogeneity in study design, measures, or descriptions of neighborhood features made comparison of gender-related findings across studies challenging. Aarts et al. [72] found that specific pedestrian or traffic calming features were associated with higher (pedestrian crossings with lights, home zones, roundabouts) or lower (street lighting) OFP in boys, but not girls, while some features were linked only with girls' OFP (pedestrian crossings without lights) [72]. In another analysis, housing-type associations with OFP varied by gender [56]. Parental perceptions of safety for OFP may differ between genders: Remmers and colleagues [79] found that boys' parents perceived higher outdoor safety in the evening compared to girls' parents. Interestingly, infant boys (0–1 years) played significantly more with natural materials in New Zealand parks than did infant girls [38]. Since infants are not independently mobile and usually heavily supervised, it is not clear if differences were due to child preference or parent facilitation [38]. The impact of social norms and adult gender modeling was evident among preschool-age girls in a US study, with one child remarking,

“Little girls can beat boys at gym, but when you get older it ain't important and you don't try.” [64, p. 152]

## Discussion

We aimed to synthesize current evidence for neighborhood built environment influences on outdoor free play in children, ages 0–6, across genders and diverse urban/suburban contexts. Our findings support a conception of playable neighborhoods as networks of physically and socially safe and engaging routes and spaces. Availability, accessibility, and acceptability of neighborhood space for play was influenced by the intersecting features of spaces, routes, and social

environments. Across widely diverse cultural and geographic settings, neighborhood space for play, green and natural environments, traffic and pedestrian environments, and neighborhood designs that facilitate social connection with neighbors support young children's OFP across contexts.

Our review highlights the importance of the first requirement for OFP: the simple availability of space, either formally designated or informal areas adapted for play, close to home. Accessibility and use of nearby playable space often depended on characteristics of routes and traffic environments. Acceptability of neighborhood space for play was related to perceptions of social safety, greenness, natural features (especially trees) and shade, park facilities, variety of affordances, seating, and opportunity to play with other children. Though built environment influences on OFP generally align with those identified in reviews with older children [19–21], some important differences emerged. Small-scale, simple features (e.g., small parks, bike racks, planters, puddles), and informal play spaces can provide important play opportunities for toddlers and preschoolers. All ages face barriers to OFP from traffic and social safety concerns; however, young children's access to neighborhood routes and space is often more severely limited by these factors. Need for parental supervision, play space proximity, parental time constraints, mental and physical health, motivation, and enjoyment of outdoor spaces may more strongly influence opportunity for OFP in young children. Thus, environments that also appeal to adults may be more important to OFP in early childhood. Reviewed studies largely focused on 2–6 year-olds; few examined or reported correlates of OFP for children under 2. Infants' interactions with neighborhood environments are completely dependent on caregiver ability, initiative, time, and preferences. Qualitative findings from our review suggest that benefits to infants may be closely linked to parental benefits derived from social connections, exposure to nature, and physical activity in supportive neighborhood environments [34, 50]. Future studies are needed to examine neighborhood features that support parent-infant outdoor co-activity and impact of these activities and exposures on infant health and development.

Though we focused on neighborhood built environments, physical features interact with family and neighborhood context and cannot be considered in

isolation from these powerful determinants of young children's OFP. Though the effects of poverty and systemic inequities extend far beyond it, they may be manifested in physical environments [92]. In our review, built environments interacted with social realities of poverty or marginalization to limit OFP. For instance, lack of nearby playable space contributed to social isolation and less OFP among new immigrants' children. Conversely, neighborhood features that facilitated neighborhood interaction could foster a sense of social safety and social connection that supported OFP. We found no consistent differences in built environment influences on young children's OFP across genders, but some evidence for social norms and gender modeling as barriers to preschool girls' OFP. Further investigation is warranted to examine social influences on gendered disparities in OFP.

Both theoretical and practical insights emerged from our evidence synthesis. From major themes, we developed a simple framework to conceptualize the interacting characteristics that influence young children's OFP. Our review highlights the contrast between child perspectives and adult assumptions of child-friendly space. Across contexts, young children desired interactions with local places and people. Active play has often been viewed as a tool for health promotion and disease prevention [93]. However, Lester and Russell argue against the conceptualization of play as a set of activities that address adult concerns but rather for the creation of "health-enabling" spaces that provide opportunity, challenge, and inspiration for children to engage in free play in everyday settings [94]. Blinkert and Weaver suggest that adults' role may be simply to protect children's right to engage with local environments [95]. Practically, our findings suggest that urban design for children must move beyond providing play destinations and toward creating playable networks, affording young children access to experiences and opportunities for interacting with local nature, structures, and people.

A major strength was this review's methodological approach: thematic synthesis of qualitative, quantitative, and mixed methods evidence enabled a comprehensive view of young children's interactions with neighborhood environments. Qualitative evidence illuminates complex and multi-level factors influencing OFP and incorporates children's perspectives in their own words. The inclusive search strategy, without language restrictions and including screening of

non-English papers, maximized context diversity. Independent screening, review, and quality assessment of all, and double coding of a subset of studies strengthened the reliability of findings.

This review had some important limitations. Among evidence from 17 countries, westernized nations were overrepresented, and no studies from Central Asia and Central or South America met inclusion criteria; thus, our synthesis is lacking input from these unique physical and social settings. Though common to young children across contexts [96], measuring and operationalizing free play is challenging. Outdoor play at young ages is usually supervised, and studies did not always specify "unstructured," "child-directed," or "free play" but was considered to be free play if outside structured, adult-directed settings. Built environment terms or meanings may differ across contexts or vary in measurement method or contributing to inconsistent findings for similar features. Despite this heterogeneity, our findings converged around the major themes across widely diverse settings.

## Conclusion

Across child gender and diverse cultural and geographic contexts, playable neighborhoods for young children provide formal or informal space for play, traffic-protected routes, and access to nature and facilitate social connection. Family and community-level social factors interact with built environments, influencing access to and engagement in outdoor free play. Efforts to standardize terms and measurements across built environment studies are needed, and socio-cultural influences on child movement behaviors across genders should be considered in future work. Research in non-westernized urban settings is needed to better understand influences on outdoor free play in these contexts. Considering young children's needs and perspectives in the design of urban and suburban neighborhoods can inform the creation of everyday environments that support optimal child health and development and more equitable, inclusive cities.

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## Declarations

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