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Associations between outdoor play features and children's behavior and health: A systematic review

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ABSTRACT

The decline of children's opportunities to play outdoors raises a new concern about the quality of outdoor play environments, and their developmental and well-being benefits for children. This systematic review aims to synthesize the associations between outdoor play features and children's behavior and health. PRISMA guidelines were followed (2021). The inclusion criteria were studies with children aged between 5 and 12 (*Population*); that addressed presence, absence or disposition of equipment, natural elements, loose parts, resources availability, type of terrain and space modifications (*Intervention or Exposure*); in pre-post intervention or between groups (*Comparison*); related to health and behavior in different domains (*Outcomes*); with an experimental, observational, descriptive or longitudinal design (*Study design*). Indoor context, adult-led activities and structured activities were excluded. A literature search of five databases (PubMed, Web of Science, ERIC, Scopus, and PsycINFO) was concluded in March 2022. After identifying 28,772 records, duplicates and irrelevant titles were removed, and abstracts and full-text articles were screened in duplicate. The remaining 51 eligible articles (45 primary studies) were assessed for risk of bias with QualSyst. A narrative synthesis of the results was conducted. The most frequent behavioral or health outcome addressed was physical activity. Included studies focused on the following space features: fixed structures, space naturalness, floor markings, loose parts/equipment, area available, and the combination of factors. Although some positive effects were found, the heterogeneity between studies did not allow to draw firm conclusions on the effects of each environmental feature on primary children's health and behavior. Systematic review registration: PROSPERO CRD42020179501.

1. Introduction

Play is essential to human development, particularly during childhood (J. L. Frost, 1998; Pellegrini and Smith, 2005), but its relevance has been neglected, in part because most adults prioritize children's academic achievements and performance (Ginsburg, American Academy of Pediatrics Committee on Communications, & American Academy of Pediatrics Committee on Psychosocial Aspects of Child and Family Health, 2007, Mitra et al., 2018; Yogman et al., 2018). Also, time for free play has been declining as it concours with formal education and other structured activities. Free play, which is structured, controlled and led by children (Wood, 2013), is mainly expressed by its spontaneity, voluntariness, and unpredictability embedded within a state of pleasure and enjoyment (Lester and Russell, 2010). To underline its importance, the United Nations established play as a right in Article 31 of the Convention on the Rights of the Child, which stresses the need to provide all children with time and space to play freely (United Nations, 1989), reinforced by General Comment n.17 (United Nations, 2013).

Play is also seen as being in the opposite side of work, given that it is a non-productive behavior and has apparently no purpose (Bateson, 2005). However, there is evidence that play contributes to developing competencies and learning skills such as problem-solving, emotion regulation, social functioning and other cognitive and motor/physical domains (Barnett, 1990; Hurwitz, n.d.; Isenberg and Quisenberry, 1988; S. Lester and Russell, 2014; Veiga et al., 2016).

Within children's engagement in primary school at 5/6 years old, adults' concerns, namely those of parents and teachers, and their expectations about learning results may naturally increase, which is

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translated into using children's free time in activities that focus on learning the school curriculum. Thus, it is even more critical at this age to stress that play is essential to children's health and well-being (Ginsburg et al., 2007; Lester and Russell, 2010). Moreover, outdoor play specifically offers a variety of opportunities that other environments cannot replace (Brussoni et al., 2015), such as more possibilities to be active, which provide several benefits related to physiological health markers (Gray et al., 2015), and with the promotion of physical, social, cognitive and emotional positive development (Tremblay et al., 2015). This progressive developmental rhetoric approach on play (Sutton-Smith, 2001) focused in its instrumental value for learning, health, and well-being deferred purposes (Lester and Russell, 2008) is a key feature for a biomedical and biopolitical policy agenda towards the promotion of children's positive and optimal development (Lester and Russell, 2014). Through this lens, a particular interest has been given to developing research-based guidelines and recommendations on children's behavioral and health domains and on adequate spatial design features, which promote the positive development of the former (Boys et al., 2022; Minhas and Nair, 2000; World Health Organization, 2021).

Along these lines, in the present research, the Ecological Psychology framework (J. J. Gibson, 1979) was adopted to think critically about the outdoor environment that should support children's free play, needs, and interests and indirectly promote their health, whether that environment is more "natural" or "constructed". From an ecological perspective, what the subjects perceive and do is a result of the interaction between their own characteristics and those of the environment (J. J. Gibson, 1979). The environment corresponds to the space where the child chooses to play (Heft, 1988) – the scene, the arena, the milieu. Hence, from now on, when "space or physical characteristics" are addressed, it is not from a geometrical perspective, but instead it is referent to the setting where the action occurs.

Gibson also refers to these environmental characteristics as structural units, components, or elements (J. J. Gibson, 1979). For instance, the surface (i.e., ground or terrain) can vary in terms of its structure: a sandy terrain, a flat bitumen area, and grassy hills. Since authors only sometimes follow this conceptual framework in the literature, environmental characteristics can be described as physical features, resources available, space characteristics, elements, structures, equipment, materials and parts.

A group of previous systematic reviews has focused on the impact of the physical environment on children's health or behavior (Adebusoye et al., 2022; Buszard et al., 2016; Gray et al., 2015; Van Hecke et al., 2018). However, those did not specifically address the moment children played freely. On the other hand, some reviews did address play and its relation with different topics, such as sensory processing (Watts et al., 2014), communication intentionality (Costa et al., 2020), participation measures (Mobbs et al., 2017), teachers' beliefs (Woods and Bond, 2018), the comparison between traditional teaching and guided play (Skene et al., 2022), or the relationships between physical and motor variables with active play (Johnstone et al., 2018; Truelove et al., 2017). However, the associations between the studied outcomes and space characteristics or qualities were not a concern in any of these cases.

Indeed, the topic of play was also systematically reviewed by some authors focusing on aspects related to the physical environment, such as the specific case of play streets (Meyer et al., 2019), neighborhood-built environments (Lambert et al., 2019), outdoor play (Truelove et al., 2018), schoolyard location (Clevenger et al., 2020) playground value (Broekhuizen et al., 2014), unstructured nature play (Dankiw et al., 2020). None allows us to conclude which physical space characteristics influence the studied outcomes.

Considering that one of the space characteristics where children play is the material available, two systematic reviews specifically focused on "loose parts". Loose parts, also called unstructured moveable materials or play props, are described as open-ended objects or materials because they are not typical toys and do not have a specific play purpose (e.g., ropes, boxes, tires, or other waste or natural materials such as sticks, leaves.). These play resources, which can be manipulated, moved, changed, and combined in different ways, allow children to use them according to the interests and needs that emerge in the play setting (Casey and Robertson, 2016; Play Wales, 2017). One of the above-mentioned systematic reviews concerns the atypical development of children's behavior (Sroka, 2006), and the other refers to the impact of loose parts play on typically developing children's cognitive, social, and emotional development (J. L. Gibson et al., 2017).

This review stands out because it stems from a broader ecological perspective on the physical features that compose spaces where children play. Specifically, it focuses on interventions/exposure that may vary according to the availability of materials, equipment, resources, structures, and other physical elements that integrate children's play niches. In addition, the present systematic review considers research that includes primary school children playing outdoors freely, focusing on multidimensional outcomes (motor, physical, cognitive, social, and emotional) related to children's health and behavior, contrasting with previous research on the field. Therefore, the present review stands out from the former according to the following terms. Firstly, it focuses on a specific age span and related themes that are scarce in the literature. Second, it is not exclusively focused on interventions/exposures that could vary in materials availability, but also in equipment, resources, structures, and other elements. Thus, to the best of our knowledge, the present review is the first aiming to synthesize the scientific evidence of the association between outdoor play features (e.g., structures, equipment, materials, resources available, or other space features) and primary school-aged children's health and behavior while they are playing freely.

2. Methods

This systematic review is registered in PROSPERO with the number CRD42020179501.

2.1. Eligibility criteria

Primary studies were considered if published in peer-reviewed journals and written in English. Papers without original data, review articles, unpublished manuscripts, protocol papers, methodological studies, studies using previously reported data, book chapters, or conference proceedings were not eligible for inclusion. Grey literature was not searched. There were no restrictions concerning the publication year. The following eligibility criteria were applied.

2.1.1. Population

Children aged between 5 and 12 years attending at least the primary school. Studies exclusively concerning children with any disabilities, disorders, or special needs were excluded. However, studies with mixed samples were included.

2.1.2. Intervention or exposure

Interventions or exposures must regard the moment when children play freely and outdoors. In addition, interventions or exposures must address one of the following features.

- presence/absence or disposition of the equipment;
- presence/absence or disposition of natural elements;
- presence/absence or variability of materials;
- availability of other resources (e.g., water, sand, mud);
- space features: total area available; type of ground;
- other physical features.

Therefore, different contexts where intervention/exposure could occur were considered: Schoolyards, Playgrounds, Playstreets, Playparks, Playing Fields, Nature Playgrounds, Adventure Playgrounds and other outdoor play areas. Studies exclusively related to indoor spaces,

classrooms, home environments, or private family spaces were excluded. Interventions or exposures regarding structured activities, adult-led activities, or outdoor classes were also excluded.

2.1.3. Comparison

Pre-post intervention programs and between-group comparisons (e.g., groups exposed to different outdoor environments) were considered. Nevertheless, studies were not excluded based on the comparator if they had a cross-sectional design without comparison.

2.1.4. Outcomes

The outcome data had to be child-level and related to behavior and/or health domains – motor, physical, cognitive, social, emotional – including but not limited to the following examples: motor skills, physical activity (PA), fitness or weight status; localization in space, relative position, trajectory and velocity; executive functions, attention restoration, problem-solving, decision-making, divergent thinking, creativity, quality of social interactions, behaviors such as collaboration/cooperation/competition, emotional competence, self-regulation, mood, affectivity, subjective well-being, stress, and play types.

Other outcomes related to children's behavior and health, such as quality of life, sleep, academic achievement, and language outcomes could also be considered. The outcomes must come from a direct measure, i.e., objective measure or direct observation. Thus, studies were excluded if the outcomes were exclusively measured by teachers or parents. Self-reports or scales were accepted as data collection techniques only when they measured emotional or social outcomes.

2.1.5. Study design

Primary studies were included if they had the following quantitative designs: Experimental, either randomized controlled trials or not; Cohort and Case-control studies; other Longitudinal studies; Cross-sectional studies, with or without comparison.

Qualitative design studies were also included for descriptive purposes, including methodologies such as Case series and Case reports, only if they were multiple or comparative case studies. Single case studies were excluded.

2.2. Information sources

Five electronic databases were used as information sources: PubMed/MEDLINE, Web of Science, ERIC, Scopus, and PsycINFO (through Ebsco). The first search was conducted in June 2020. Nevertheless, due to the length of the review, a second search was conducted, replicating the same strategy, in March 2022.

2.3. Search strategy

The search strategy was adapted to each one of the electronic databases. Whenever possible, terms truncation was used, as well as Boolean operators. If the search engine allowed to limit results, the following filters were applied: language "English" and peer-reviewed only. The terms used were preferentially MeSH terms and corresponded to the PICOS components.

- Population: child, children, childhood, kid, girl, boy, youngster;
- Activity: play, ludic, leisure, recess, recreation, free, child-led, unstructured;
- Context: outdoor, schoolyards, playground, street, park, playfield, nature, forest, adventure, public space;
- Space features and resources: space, setting, area, characteristic, feature, ground, equipment, structure, material, loose parts, resources, natural elements, fixed, portable;
- Outcomes: health, behavior, development, motor skills, social skills, well-being.

For further details, see Appendix A, which shows the search strategy.

2.4. Selection process

From the sum of studies identified in all databases, duplicates were removed by one reviewer (J.V.P.) using Mendeley software. The same person screened titles, with a second reviewer (R.C.) checking 10% of the titles. Three reviewers independently screened abstracts: one (J.V.P.) reviewed the total number of records, and the other two screeners (F.V.N. and G.V.) reviewed one-half each to have a double rate per record. In case of disagreement, a fourth reviewer (F.L. or R.C.) made the final decision. The same procedure was done for full-text screening. In this case, the disagreements were solved through discussion with all team members. All the decisions respected the inclusion/exclusion criteria defined in the beginning. Even so, when researchers found that the criteria were not sensitive and rigorous enough, the criteria table was rewritten and upgraded (see the final version in Appendix B).

2.5. Data collection process & data items

2.5.1. Data extraction

To collect data from the included reports, an Excel worksheet was previously structured to fill in with the following information: authors; year; the country where the data were collected; theoretical framework; sample characteristics (total size, age, sex, year level); type of study (qualitative, quantitative) and specific design, comparator (either with a control group or between moments); characteristics of the intervention or exposure (duration, frequency, context, use of materials); outcome name, type and measure; and main results. For the qualitative studies, the worksheet was adapted. One researcher (J.V.P) made these steps, while another (F.V.N.) cross-checked the extracted data.

2.6. Risk of bias assessment

Given the quantitative studies, the tool used to assess the risk of bias and methodological quality was the "Checklist for assessing the quality of quantitative studies" from "QualSyst" (Kmet et al., 2004). This tool was chosen because in the preliminary search, many quantitative studies were not randomized, and this checklist is more extensive and can cover the appraisal of diverse study designs.

The 14 checklist items (Appendix C) encompass several possible biases in different study phases: selection, allocation, control of confounding, intervention classification, outcome measurement, and results reporting. For each record, all items were scored in one of three levels ("yes" = 2, "partial" = 1, "no" = 0), depending on the degree to which the specific criteria were met. If the items were not applicable to a particular study design, "n/a" was marked and excluded from the calculation of the summary score. For the overall risk of bias, a summary score was calculated for each record by summing the total score obtained across relevant items and dividing it by the total possible score (28 – (number of "n/a" x 2)). Due to the nature of the studies included in the review, random allocation and blinding of the investigators and subjects (items no. From 5 to 7) were not considered in the total score.

As qualitative studies were admitted, the "Checklist for assessing the quality of qualitative studies" from the same authors was also used. A total of 10 items (Appendix D) are rated in three levels, as previously, encompassing components such as theoretical basis, sampling strategy, data collection, description and analysis, credibility indicators, and reflexivity. Unlike the previous checklist, "n/a" was not permitted to be assigned to any of the items. For the overall risk of bias, a summary score was calculated for each record by summing the total score obtained across the ten items and dividing by 20 (the total possible score).

This tool's reliability meets accepted standards (Kmet et al., 2004). Two pairs of researchers have independently rated each record against the appropriate appraisal tool and a third researcher has resolved any differing scores.

2.7. Strategy for data synthesis

Contrary to the initial plan, performing a meta-analysis within the quantitative studies was not possible due to their heterogeneity, particularly concerning the methodological diversity and the different measured outcomes. For this reason, a narrative synthesis was performed. One reviewer independently synthesized data during this process, and a second person validated it.

3. Results

3.1. Study selection

Considering the five databases, 28,772 records were identified, as presented in Fig. 1 (PRISMA flow diagram). After removing duplicates (n = 8913), 19,859 records were screened. From the retrieved 993 records, the abstract screening led to 183 full texts, which were then assessed for eligibility. Of those, 132 did not meet inclusion criteria, with the primary reasons for exclusion detailed in Fig. 1. Finally, 51 eligible articles remained, corresponding to 45 primary studies.

3.2. Study characteristics

The complete extraction table is presented in Appendix E. Only papers' information concerning the inclusion criteria was extracted for the present review. If the results of any included paper also addressed differences between children's ages or sexes, those results were not considered, given that only outcome associations with space features were of interest and those variables were out of scope. The same applies to study results that derive from an outcome measure that was not initially considered for inclusion.

3.2.1. Geographical location & publication year

The included studies were conducted in several countries: Australia (n = 13), USA (n = 7), England (n = 6), The Netherlands (n = 5), as well as in Denmark, Finland, Norway, Spain, Sweden (n = 2, each), and New Zealand, France, Germany, Ireland (n = 1, each).

Although all publication dates were accepted, only two included papers were published before 2005. Five of the remaining 49 records were published between 2005 and 2009, twenty between 2010 and 2014, eighteen between 2015 and 2019 and six either during or after 2020.

3.2.2. Theoretical framework

Given the different frameworks found across the records, a content analysis was performed to form categories, of which the relative frequencies are reported. From the five emergent categories, the most frequent was "physical activity (PA) promotion" (n = 29), followed by "ecological psychology approach" (n = 10), and "nature exposure benefits" (n = 5). The least frequent category was "play importance" (n = 4), and finally, three theoretical frameworks were categorized as "other", meaning they did not belong to any of the previously mentioned categories.

3.2.3. Study designs

The 45 included studies encompass 51 articles, some of which (n = 11) had a qualitative approach, while 40 were quantitative. Quantitative designs were divided into four types: Cross-sectional without comparison (n = 15), Cross-sectional with comparison (n = 10), Uncontrolled before-after (n = 5), and Controlled before-after (n = 10). The 'Uncontrolled before-after' and 'Controlled before-after' types represent the interventional studies (n = 15), six of which have three data collection moments.

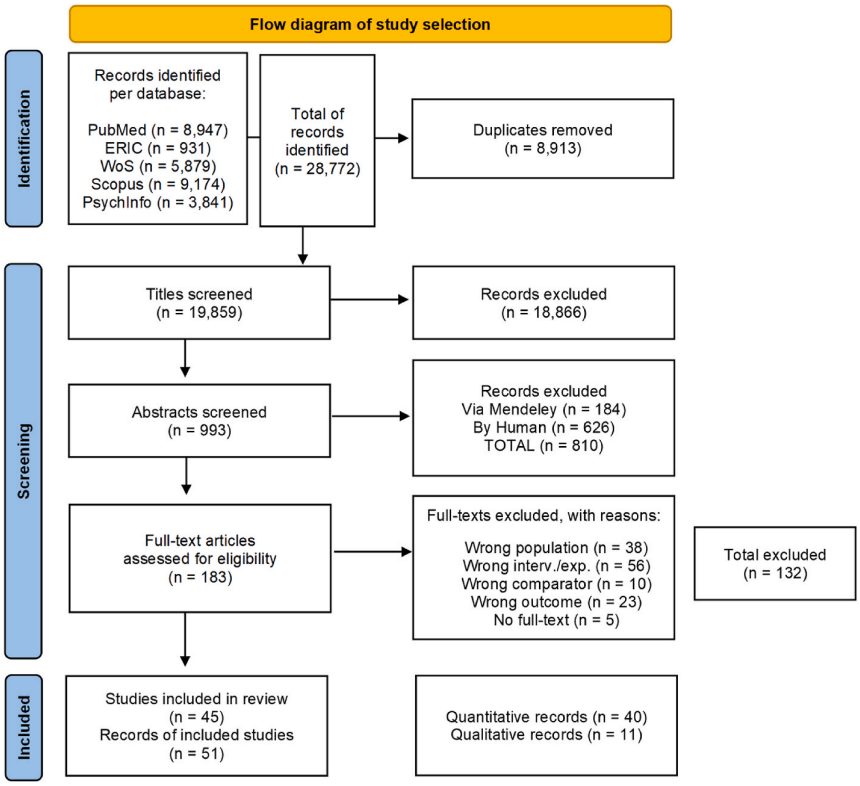

Fig. 1. PRISMA flow diagram.

3.2.4. Sample size and participant characteristics

The studies' participants were mostly recruited from the school context, with only five studies having participants from a public space context, such as parks or playgrounds.

The records total up to 53,851 participants, ranging from 12 to 36,995 children per sample, with a median of 159 (IQR = 59–420). Three studies did not report sample size. All studies included boys and girls, except one (only girls), and ages ranged between 5 and 12 years.

3.2.5. Exposures and interventions

As detailed before, the interventional studies' records were those categorized as having a before-after design (n = 15), and all the others that had an exposure were either cross-sectional (n = 25) or qualitative (n = 11).

The contexts to which children were exposed or where the interventions occurred were primarily schools (n = 38). Of these, 18 studies were conducted in only one or two schools. Another 19 studies encompassed between three and 10 schools. Nine studies encompassed more than 10 schools. The remaining studies were conducted in non-school settings, such as the public spaces, gardens, parks, or public playgrounds.

Of the quantitative studies, 15 were interventional (pre-post or three moments), and 25 were cross-sectional, in which children were exposed to a specific context with certain space characteristics.

Of the interventional studies, there were four types of changes most commonly used alone or in combination with each other: installing new fixed structures, painting marks on the floor, naturalizing the spaces, and providing loose materials or sports equipment.

Five of the interventions were based solely on introducing loose materials into the spaces where the children used to play (Bundy et al., 2008, 2009; Chard and Pierse, 2011; Engelen et al., 2018a,b; Fjørtoft et al., 2009; Hyndman et al., 2014). Three interventions were based on redesigning the space to naturalize it, turning spaces into green areas, and introducing shrubs and trees (Raney et al., 2021; Raney et al., 2019; van Dijk-Wesselius, Maas, Hovinga, van Vugt, & van den Berg, 2018). One study evaluated an intervention based only on painting floor markings (Stratton, 2000). Another study evaluated exclusively fixed structures' introduction (Hamer et al., 2017). Four studies made interventions in the space combining several aspects, such as painting floor markings and providing sports equipment (Blaes et al., 2013; Lopez-Fernandez et al., 2016), painting floor markings and introducing fixed structures (Ridgers et al., 2007), painting floor markings, introducing fixed structures, naturalizing some areas, providing sports equipment (M. C. Frost et al., 2018).

The space features considered on the cross-sectional studies were the fixed structure quality or quantity, the "naturalness" of the space, the presence of materials, and the area available per child.

Six studies considered fixed equipment, of which four (Dalene et al., 2016; Hamer et al., 2017; Nielsen et al., 2012; Taylor et al., 2011) focused on the number of structures (quantity of play facilities), while the other two compared different qualities of the structures (Schaaf et al., 2020; Sporrel et al., 2017): more or less standardized configuration; and degree of open function. Five studies compared terrain sizes (or area available per child), of which two exclusively (Escalante, Backx, Saavedra, García-hermoso, & Domínguez, 2012; Harten et al., 2008), while the other three combined terrain size and fixed structures quantity (Dalene et al., 2016; Grunseit et al., 2020; Nielsen et al., 2012). Four studies compared natural or greener environments with environments considered more artificial, constructed or having paved areas (Bagot et al., 2015; Fjørtoft et al., 2009; Martensson et al., 2014; Wood et al., 2014),. Only two studies considered the presence of materials (Grunseit et al., 2020; McKenzie et al., 2010).

Ten cross-sectional studies considered mixed environmental characteristics of the space where children played, without necessarily comparing different spaces. Two studies (Adams et al., 2018; Luchs and Fikus, 2013) compared different playground types categorized as "naturally structured, traditional, contemporary, and adventure." Three studies (Martin et al., 2012; Ridgers et al., 2010; Van Kann et al., 2016) assessed spaces that varied in terms of available area per child combined with other factors of fixed or mobile equipment (both quality and quantity). Another five studies (equivalent to six published records) (Andersen et al., 2015; Anthamatten et al., 2011, 2014; Howe et al., 2018; Pagels et al., 2020; Willenberg et al., 2010) did not consider the available area per child. However, they took into account the variation of many aspects of the space in combination with each other, such as the type of floor, the presence of green areas with more or less fixed structures, and their variety, the marks painted on the floor and the spatial structuring, material provided, the presence of other elements.

The qualitative studies explored some environmental characteristics common to the quantitative studies, such as green space availability, total area per child, features qualities or type of fixed and moveable equipment. These studies also explored some specific aspects of the spaces where children tend to play that could help to understand their behavior, like the case of the enclosures, staircases, gardens, or public streets in the neighborhood that end in a cul-de-sac.

3.2.6. Outcomes

Of the eligible studies, 12 had more than one type of outcome, and all the others were related to a specific outcome domain. PA was the more frequent domain, followed by studies focusing on some aspect of children's play behavior; or less frequently focusing on user's preference or attractiveness of the space elements. Few studies focused on social outcomes; quality of life, well-being or enjoyment; motor development and cognitive outcomes (restorativeness and attention restoration).

Of the eligible studies, 30 chose PA as the primary outcome (25 exclusively and six in combination with other outcomes). The most common measurements were accelerometry, sometimes combined with GPS or heart rate monitors, and direct observation instruments (e.g., SOPLAY, SOCARP). Behavior mapping and focus group techniques were also used in some qualitative studies, in addition to observation.

Fourteen studies focused on some aspects of children's play behavior, such as the number, duration, and type of play episodes, playfulness, various types of activity, or types of play. Among these, seven focused specifically on children's preferences as users of a given space, such as preference for specific places, the attractiveness of structures, or the distribution of children by location, by type of elements, or by type of configuration (of the same elements), and also on their aesthetic appreciation of the playground.

The five studies that addressed social outcomes combined this category with one of the previous two (PA or play behavior), assessing prosocial orientation or quality of social interactions, social group size, and socio-emotional well-being.

Two studies addressed cognitive outcomes, more specifically, restorativeness and attention restoration. Also, only two studies had outcomes related to motor development, which measured fundamental motor skills (FMS). Finally, two studies evaluated outcomes such as quality of life, well-being, or enjoyment.

To conclude about the associations or effects on the outcomes described above, many studies controlled for other variables such as age or year of schooling, gender, anthropometry, fitness, socio-economic status, ethnicity, the area available per child, climate (including temperature, sun exposure, and season), time of day, and length of playtime.

3.3. Risk of bias

The last column of the extraction table (Appendix E) presents the QualSyst total score for each study. In quantitative studies quality scores ranged from 0.5 to 1.00, with an average of 0.88 (0.13). Qualitative studies quality score ranged from 0.5 to 1.00, with an average of 0.82 (0.17).

3.4. Results of individual studies

Due to the heterogeneity of the data, conducting a meta-analysis of the studies' findings was not possible. An attentive approach was taken towards the methodological specifications of each record, the different outcomes measured, and the various interventions and exposures. Consequently, it was necessary to conduct a narrative synthesis of the individual studies' results. Information was aggregated based on the environmental factors addressed in the studies' interventions or exposures.

PA was conspicuously reported as a study outcome. Therefore, studies were aggregated in three sub-sets when reporting the outcomes for each environmental feature. Starting with one solely focused in PA, followed by one focused on PA and other outcomes, and finally, those that focused only on others outcomes different from PA.

3.4.1. Fixed equipment

Twelve studies assessed how children's behavioral outcomes were influenced by or associated with fixed equipment, structures, or permanent play facilities in terms of quality or quantity.

Among those, nine specifically focused on PA outcomes. Three studies showed a significantly higher proportion of PA in zones with fixed equipment or constructed features compared to other types of settings (Anthamatten et al., 2011, 2014; Howe et al., 2018; Willenberg et al., 2010). Similarly, a positive correlation existed between fixed equipment and more MVPA (moderate to vigorous physical activity) (Van Kann et al., 2016) and less sedentary behavior - SB (Dalene et al., 2016; Van Kann et al., 2016). However, the provision of permanent play facilities was also associated with higher LPA (low physical activity) time scores in younger children (Dalene et al., 2016). Three studies specifically evaluated the number of fixed equipment pieces. While two of these studies reported positive associations with PA (Nielsen et al., 2012; Taylor et al., 2011), one study did not find a significant association between the number of fixed equipment and PA (Ridgers et al., 2010).

Only one study evaluated the impact of an intervention involving adding new fixed structures to the playground on children's PA. This study showed significant decreases in total SB and increases in total LPA for children in the intervention group (under 9 years old), but no differences between groups in total MVPA, LPA, and SB (Hamer et al., 2017).

Only one study has explored the relationship between the quantity of fixed equipment and cognitive outcomes, concluding that the former does not predict perceived restorativeness (Bagot et al., 2015).

Furthermore, two studies focused on the impact of the quality of structures on children's behavior. One study demonstrated that children preferred, and spent more time engaging with, fixed elements of a non-standardized configuration as opposed than those with a standardized configuration (Sporrel et al., 2017). The other study suggested that children were less drawn to elements with an open-ended function (e.g., non-traditional play elements with abstract forms) (Schaaf et al., 2020).

Additionally, two qualitative studies indicated a stronger preference among children for playing in areas equipped with fixed installations over other settings, such as courts devoid of fixed equipment (Kreutz et al., 2021; Li and Seymour, 2019). Another study found that children choose play areas situated between other formal spaces (Aminpour et al., 2020).

3.4.2. Floor markings

Three studies have examined how floor markings influence or are associated with children's behavior, with PA being the only outcome domain addressed. One study found that children engaged in more MPA when the floor had court markings than when it did not, but this was only observed in bitumen settings (Willenberg et al., 2010). These findings suggest an influence of floor markings on MPA in these settings. However, another study found no statistical association between PA and the presence of markings in the playground (Ridgers et al., 2010).

In addition, an interventional study discovered a significant interaction effect of floor markings with MVPA, VPA, and heart rate (Stratton, 2000). However, no main effect was observed between the experimental and control groups. This indicates that while painting marks can increase PA, they are not the main factor (Stratton, 2000).

3.4.3. Naturalness of the space

Most studies comparing naturalized and artificial environments have primarily focused on the impact or relationship with PA. However, they also consider other outcome domains, such as children's social, cognitive, and play behavior.

Specifically, four studies evaluated the relationship between green spaces and PA. Two of these studies reported a higher proportion of PA in green settings compared to other environments, such as artificial solid surfaces (Andersen et al., 2015; Wood et al., 2014). In contrast, one study found a negative correlation between the absence of green space and SB (Van Kann et al., 2016). Nevertheless, another study found no significant differences in PA when comparing naturalized and artificial environments (Martensson et al., 2014).

In terms of studies comparing green play settings with other types of environments across multiple outcomes (including PA and others), it was reported that interventions involving natural greenery led to children spending significantly more time in MVPA, exhibiting reduced SB, and engaging in more prosocial interactions (Raney et al., 2019, 2021). One study demonstrated that greenery intervention positively influenced PA specifically for girls and also had a beneficial effect on attention restoration, social well-being, and children's appreciation of the schoolyard; however, it had no impact on emotional functioning (van Dijk-Wesselius et al., 2018). In contrast, another study (Fjørtoft et al., 2009) found that an asphalted schoolyard elicited more locomotion, while a forest area prompted physical exploratory behavior.

Two studies concentrated solely on outcomes unrelated to PA. One study found that a naturalized play environment facilitated fewer, yet longer, play episodes and a greater diversity of play types compared to a "contemporary" playground (Luchs and Fikus, 2013). The other study discovered that both the percentage of grass coverage and the volume of vegetation were positively associated with perceived restorativeness. Furthermore, the volume of vegetation was identified as a predictor of restorativeness (Bagot et al., 2015).

Regarding the conclusions drawn from qualitative studies, there appears to be a preference among children for natural and green spaces (Aminpour et al., 2020; Kreutz et al., 2021; Li and Seymour, 2019; Lucas and Dyment, 2010). This preference can promote more active play (Brockman et al., 2011), lead to a greater diversity of play types (Laaksoharju and Rappe, 2017; Li and Seymour, 2019), and encourage social interaction (Laaksoharju et al., 2012).

3.4.4. Loose parts and loose equipment

Nine studies evaluated the association or impact of loose parts on children's health and behavior. Most of these studies centered on PA, while a few examined play behavior or emotional outcomes.

Concerning the studies focusing on PA, when loose play equipment was provided, children engaged in more VPA (Willenberg et al., 2010). They increased their chances of being in the healthy cardiorespiratory fitness zone (Grunseit et al., 2020). Similarly, children's MVPA was higher in areas with loose equipment than in those without (McKenzie et al., 2010), and in another study loose equipment was a predictor of more MPA and less SB (Ridgers et al., 2010). One interventional study also showed that children significantly increased PA when loose parts were available (Bundy et al., 2009).

Another study explored the effects of a loose parts intervention on different domains together: PA, enjoyment, and quality of life (Hyndman et al., 2014). Results revealed a positive effect of the intervention with loose parts on children's PA levels, both seven weeks and eight months later. It also suggested a positive effect on their enjoyment

of PA and quality of life (subscale of physical health) that remained for seven weeks.

Regarding the effect of loose parts on outcomes other than physical activity PA, two studies assessed the influence of loose parts interventions on children's playfulness. One study found a positive effect (Bundy et al., 2008), while the other study reported no significant effect (Chard and Pierse, 2011). Another study examined play types as an outcome, concluding that loose materials were consistently high and positively associated with creative play and construction play and negatively associated with inactive play (Engelen et al., 2018a,b).

One qualitative study explored the play types and social behavior related to the introduction of portable equipment. It found that children were more collaborative, creative, and more likely to negotiate with their peers (Mahony et al., 2017).

3.4.5. Area available or size

Seven studies focused on how the play area or size influenced or was associated with children's behavior, with PA being the most focused outcome domain.

In two studies, children in larger play areas were significantly more active than children in smaller play areas (Escalante et al., 2012; Harten et al., 2008). Similarly, another study found that the play area/size predicted more VPA and less SB (Ridgers et al., 2010). Conversely, one study concluded that the space availability for children was positively associated with SB (Van Kann et al., 2016), and another study showed that the associations between PA and play area/size were negligible (Dalene et al., 2016).

The two studies on other outcomes addressed motor and cognitive domains. One showed no relationship between playground size and proficiency in FMS (Grunseit et al., 2020). The other revealed that the play area size was not a predictor of perceived restorativeness (Bagot et al., 2015).

Qualitative data showed that some children in small play areas feel crowded, contributing to reduced PA in those children (Pawlowski et al., 2018; Pawlowski et al., 2019). At the same time another study stressed the preference of some children to play in areas such as "small enclosures" (Aminpour et al., 2020).

3.4.6. Conjugation of environment characteristics

Seven studies assessed the relationship between or the impact of multiple space features on children's behavior and health. Given that fact, it was impossible to report the specific space characteristic linked to the outcome, but instead, a combination of characteristics.

Two cross-sectional studies focused on PA and FMS (Adams et al., 2018; Andersen et al., 2015). The first compared three types of play spaces: traditional, contemporary, and adventure playgrounds (Adams et al., 2018). The authors did not find associations between the number of FMS and the different environments, nor differences in children's VPA. Children spent more time in MVPA in traditional playground compared to the other two types. The other study also addressed PA outcomes, comparing five different environments: grass area, multi-court, playground, flat paved area, and natural area (Andersen et al., 2015). Results showed that MVPA mainly occurred in the grass area, followed by the playground. The flat paved areas had the highest proportion of time spent in SB.

A single qualitative study also concluded that playground redesign provided novelty and more attractiveness for children (Van Andel, 1985).

Other four interventional studies contributed to a better understanding of how the conjugation of multiple space features contributed to children's PA. One study reported that playground redesign with floor markings and new fixed structures significantly increased recess PA (Ridgers et al., 2007). Two other controlled studies showed that when combining floor markings and the provision of loose play equipment in the intervention, there is a positive effect on children's PA (increases in MPA, MVPA, and VPA, and decrease in SB) (Blaes et al., 2013; Lopez-Fernandez et al., 2016).

Another study also evaluated the impact of a playground redesign intervention on children's PA, reporting significant changes in MVPA and VPA that were sustained one year later. However, this time the redesign encompassed different structural equipment changes, replacing or adding fixed structures, green areas, markings, and loose parts (M. C. Frost et al., 2018).

4. Discussion

This systematic review aimed to compile evidence on the relationship between the characteristics of the physical space (outdoor play features) and the health and behavior of school-aged children. This section is structured in two axis, one related with the critical approach to the evidence that was found, along with the strengths and limitations; and another, which indirectly ripples from the former, as an opportunity to address the interrelatedness of the research topics from a novel perspective.

4.1. Critical approach to generated evidence

Of behavioral or health outcomes addressed, the most frequent (67%) was physical activity (PA). Also, most of the theoretical frameworks of the included studies (56%) were based on a perspective of promoting PA. This prominence may be related to the historical evolution of public health recommendations and international guidelines for PA that were published in the last two decades (Blair et al., 2004; Parrish et al., 2020; WHO, 2020). The increasing emphasis on PA is also noticeable when looking at the publication years of the articles included in the present review.

Moreover, despite the WHO definition of health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO Interim Comission, 1948: 100), the conception of health focused on physical aspects is still prominent in western societies (Conti, 2018). The current policies and practices still undermine a comprehensive perspective on health, which includes an emphasis on the relation between health and place (Moon, 1995) and how people affect and are affected in their construction of health-enabling spaces (Duff, 2011).

The fact that few records studied other outcome domains (cognitive, social, emotional, or motor) does not necessarily mean that previous literature has not addressed these. Instead, it could mean that: i) researchers who give attention to these domains do not necessarily study the relationship between them and the characteristics of the physical space; ii) when this relationship is considered, the concern might be on younger children, i.e., preschoolers (Branje et al., 2021; Maxwell et al., 2008; Moreira et al., 2022; Storli and Hagen, 2010); or iii) the emphasis might be on the effect of interventions during structured moments, directed by adults (Pérez-Clark et al., 2022) and not on moments when children play freely.

Different environmental characteristics were addressed regarding the results of individual studies included in this review. There seems to be a positive association between the existence and number of fixed structures and PA. However, one interventional controlled study found that this trend was not maintained one year later (Hamer et al., 2017), suggesting that a novelty effect might have existed. We hypothesize that for changes to persist in the long term (e.g., after months), the quality of fixed structures should also be considered, not merely its existence or quantity. As only two studies addressed the qualitative aspects of structures, clear evidence about this issue could not be obtained (Schaaf et al., 2020; Sporrel et al., 2017). This aspect should be explored in future studies. All floor marking studies exclusively addressed the PA outcome, with the majority showing positive associations between these variables. However, in an experimental study (Stratton, 2000), the impacts did not translate into significant differences between groups, thus suggesting that floor markings may be an important factor in stimulating

PA, but not a determinant one.

As for the naturalness of the space, there tends to be a positive relationship between this environmental feature and PA levels, although some studies present contradictory results. Naturalness also positively impacts social and cognitive outcomes.

All studies regarding loose parts or equipment associate these with higher levels of PA. This consensus regarding the effect of loose parts has not always been found in previous research with other age spans (Houser et al., 2016), which may be because loose parts can vary widely between studies and offer opportunities to engage in different types of play (Nicholson, 1971; Play Wales, 2017). In this regard, two important considerations should be taken into account. First, loose parts and types of play afforded by them may include more or less physical activity and even the absence of it, and movement associated with these types of play may not always be referred to as physical activity. Studies about the relationship between loose parts and socio-emotional outcomes, playfulness, and play types are inconclusive, pointing in different directions.

Inconclusive evidence was found on the relationship between the available area (relative space per child) and PA. Although the evidence is scarce, there was also a lack of associations between this variable and other motor and cognitive outcomes.

The studies' results related to several environmental factors of the space showed that a combination of factors could lead to changes in children's PA, which are more sustained in the long term (e.g., six months or one year after), when compared with the effects of interventions focusing in only one space feature. However, the specific reason for this effect is still unclear.

4.1.1. Limitations of reviewed evidence

There is a lack of comparative studies that evaluate variations in only one of the space characteristics, meaning that most of the cross-sectional studies compared diverse environments that differed in multiple ways. For instance, no studies exclusively compared some specific features, e.g., different surfaces, the presence or absence of slopes or hills in the terrain, or using the same type of materials but varying only in size. Few studies in this review greatly reduced the variability of the compared situations, making it difficult to discern the specific effects of each environmental feature. Alternatively, when confounders cannot be controlled because data collection occurs in an ecological context (e.g., school, public space), a more exhaustive description of the environmental characteristics and materials should be provided. For instance, some studies reported they compared the "playground" with the "field", but the notion of playground or field can vary widely, so it does not provide sufficient descriptive detail. In addition, when referring to "sports equipment" or "materials", authors should be aware that those terms might not be clear or might not mean the same for researchers in different areas (e.g., landscape architecture, physical education, developmental psychology, dermatology). By describing circumstances in detail and presenting clear definitions of concepts, it is possible to avoid divergent interpretations by readers. As an effort to mitigate conceptual divergence in the field of play, learning and teaching outdoors (PLaTO), very recently, a group of researchers and scholars, through a set of systematic and iterative processes, developed a harmonized and consensus-based terminology and taxonomy for 31 PLaTO terms (Lee et al., 2022). Another limitation of the reviewed literature is the low methodological quality of the papers, given that many studies were rated with 0.5 points on a scale ranging from 0 to 1 point, according to the tool used to measure risk of bias (Kmet et al., 2004).

Although this review identified many environmental factors previously studied (fixed structures, space naturalness, floor markings, loose parts/equipment, area available, and the combination of factors), there are still many specificities and qualities of the environment that have not been empirically studied, in the field of outdoor free play, for this age range. Particularly, factors that have been listed by authors from the ecological paradigm (Heft, 1988; Kyttä, 2002): type of surface, its hardness, roughness, constitution; presence of slopes and everything that alters the continuity of the surface; structures or elements that are climbable; the presence of apertures or shelters (either natural or constructed); qualities of objects such as shape, size, weight, stiffness, texture, or the total number of elements available, whether they are loose or fixed; the existence of other moldable material elements (water, sand, earth).

4.1.2. Strengths and limitations of the present review

The present review allowed for a comprehensive analysis of the evidence regarding the association between outdoor play features and primary children's health and behavior, considering a wide range of studies with various designs and outcomes. To the best of our knowledge, this is the first time that the impact of environmental space features is studied during free play, in the outdoor environment, in this age group. The decision to include a wide range of study designs, and not to limit the outcome domains, led to many articles being retrieved. This process was time-consuming, and a second search was needed so that the results were not outdated.

As for the review process, some limitations were noted. First, the inclusion criteria considered only peer-reviewed papers written in English, with no search for grey literature. Second, due to the number of records identified (28,772), title screening was not conducted in duplicate. Third, the QualSyst appraisal tool (Kmet et al., 2004) used for methodological quality analysis was chosen because it suits a variety of study designs. However, this probably led to an under-valorization of studies with interventional controlled designs compared to other studies. The option for a tool that would value interventional controlled designs would not have fitted most studies included in this review. Finally, it was challenging to ensure that all studies included were effectively about moments of free play since its definition is inconsistent (Pellegrini, 2009). It is important to acknowledge that play discourses and they forms have emerged through their ambiguities (Sutton-Smith, 2001).

4.2. Another viewpoint on outdoor play features, health and behavior

The biomedical legitimate concern, which underlies the focus of the present review, relates with understanding which outdoor play features better provide opportunities for children to achieve a healthy development. This perspective renders well-being as an individual conquest and play as a set of predetermined behaviors that may be used to achieve such healthy developmental outcomes. In terms of a policy stance characterized by this biomedical account, the lack of robust empirical evidence about the effects of different space features on children's health and developmental domains raises tangible doubts about the creation of sustained evidence-based guidelines for the planning and design of appropriate outdoor spaces that concur with children's positive development, health, and well-being.

Playing in its various shapes, modes and ways results in how bodies, space, objects, desires, histories, materials and much more affect and are affected, within and from them, as entanglements, which are often unpredictable and that generate a being well state in the time of playing (Lester and Russell, 2014; Lester, 2019; Lopes, 2021, Russell et al., 2024). Conversely, the adoption of a biomedical stance on play and well-being, draws on an instrumental perspective of desirable play behaviours and forms and their deferred developmental and well-being benefits, marginalizing other forms of everyday playing and playful uncertainties immediately relevant for children's everyday school livable experiences.

Recently, Russell, Barclay and Tawil (2024), in their narrative review on children's play, social policy and practice refer to "Play" as "Playing" and "wellbeing" as "being well", which results on "Playing and being well". Throughout the work, authors have adopted a "relational capabilities approach" to children's play. This accounts for the entanglements that steam from and through personal, social and environmental conditions, which affect how children actualize the available play

resources into moments of playing. Simultaneously, these playful capabilities come along with an immediate being well state and as long-term well-being. This relational approach means acknowledging that play and well-being are not individually set on children's bodies and minds, but emerge both from and within those entanglements (Lester, 2019).

The inconclusiveness of our research findings affords the possibility of looking at play and well-being adopting a more relational perspective, which is attuned with play as a health-affirming process within itself. Also, this perspective offers additional contribution to the present field of research, as well as to policy and practice.

5. Conclusion

This systematic review shows that the environment's physical characteristics somehow influence children's behavior and opportunities for action in contexts where they choose what they do autonomously and freely.

Most of the studies included in this systematic review were conducted in a school setting. Among all the space characteristics addressed in the included studies, it still needs to be determined which ones, how, and to what extent they promote the development and health of school-aged children when they are exploring the environment freely.

PA was the most studied outcome in this area. Fixed equipment, green space, and loose parts seemed to be most likely associated with higher PA. Emotional and cognitive outcomes were less explored and also presented inconclusive results.

A critical appreciation of our present work and its findings, including questioning the dominant developmental rhetoric on play benefits, leads us to propose a shift in the perspective toward the design of outdoor play spaces. This process would benefit from focusing on the relational conditions that the children need to have to engage in moments of playing and being well. These conditions, which tend to be unpredictable and are essential both in the time-space of playing, but also for experience well-being later in life.

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CRediT authorship contribution statement

Joana V. Pereira: Conceptualization, Data curation, Formal analysis, Funding acquisition, Writing – original draft. **Fabio Vila-Nova:** Data curation, Formal analysis, Validation, Writing – review & editing. **Guida Veiga:** Validation, Writing – review & editing, Formal analysis. **Frederico Lopes:** Conceptualization, Supervision, Validation, Writing – review & editing, Formal analysis. **Rita Cordovil:** Conceptualization, Formal analysis, Funding acquisition, Project administration, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

Authors declare they have no known conflict of interest to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.healthplace.2024.103235.

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