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Research Article

Frequency and duration measurements of children's outdoor free play: A Scoping review

Rachel Ramsden[1], Michelle O'Kane[2], Eva Oberle[3], Mariana Brussoni[4]

Abstract: Outdoor free play encompasses unstructured, self-directed play in the outdoors and has been shown to support children's health and development. Accurate and reliable measures are required to conduct research on children's outdoor free play and examine cross-sectional and longitudinal variation. This study systematically reviews and evaluates measurement approaches for children's outdoor free play used in existing literature. A scoping review was conducted to identify English-language peer-reviewed and grey literature that included measurements of the occurrence, frequency or duration of outdoor free play with children aged 2 to 17 years old. Studies were excluded if the outdoor free play measure included structured settings or activities, or focused on a specific location or play activity. Quantitative and qualitative content analysis was used to consider outdoor free play terminology, definition, and operationalization; positioning in relation to other variables and the topic of interest; and data collection context. A total of 4,860 unique studies were identified. After screening and full-text review, 184 papers were taken forward for analysis. Parent-recall questionnaires were used in 70.1% of included studies to measure outdoor free play, often using a single question to capture the variable. A lack of differentiation between outdoor play emanating from structured and unstructured settings was common, as was limited consideration of contextual factors such as season, school or non-school days, and time of day. The implications of existing approaches to measuring children's outdoor free play and the need for valid and reliable measures to further research examining children's outdoor free play are discussed.

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Introduction

Outdoor play for today's generation of children differs from that experienced by their parents or grandparents in both quantity and type (Clements, 2004; Solomon-Moore et al., 2018). Increasing urbanization and car dependency, screen-based leisure time, and shifting work patterns and family lifestyles, have reduced the opportunities for children to be outside and at play (Charles et al., 2008; Clements, 2004; Cordovil et al., 2015; Lester & Russell, 2014; Singer et al., 2008). Parents face increased societal pressure to focus on the protection, safety and supervision of their children, further limiting children's autonomy over their play (Lee et al., 2015; Valentine, 1997). The types of outdoor activities in which children participate have accordingly shifted, with more time spent in adult-led, organized, structured activities, such as sports groups or after school clubs (Sublette & Mullan, 2012; Watchman & Spencer-Cavaliere, 2017). Adult interaction significantly shapes children's choices and behaviour, and children tend to be more conscious of their actions or movements in the presence of adults, which influences their overall play patterns (Bento & Dias, 2017; Bundy et al., 2011).

The importance of outdoor play on the health, development and well-being of children has been extensively documented, including enhancements to cognitive, physical, emotional and social domains,

[1] University of British Columbia, Faculty of Medicine, Department of Pediatrics Vancouver, Canada; University of British Columbia, Human Early Learning Partnership, Vancouver, Canada; BC Children's Hospital Research Institute,Vancouver, Canada, email: rramsden@bcchr.ca, ORCID: https://orcid.org/0000-0003-0741-3951

[2] University of British Columbia, School of Social Work, Vancouver, Canada, email: milenoka@student.ubc.ca, ORCID: https://orcid.org/0000-0002-1434-2517

[3] University of British Columbia, Faculty of Medicine, School of Population and Public Health, Vancouver, Canada; University of British Columbia, Human Early Learning Partnership, Vancouver, Canada, email: eva.oberle@ubc.ca, ORCID: https://orcid.org/0000-0001-7815-2563

[4] University of British Columbia, Faculty of Medicine, Department of Pediatrics Vancouver, Canada; University of British Columbia, Human Early Learning Partnership Vancouver, Canada; BC Children's Hospital Research Institute, Vancouver, Canada, email: mbrussoni@bcchr.ubc.ca, ORCID: https://orcid.org/0000-0002-1495-816X

boosting Vitamin D levels, spatial awareness, and impacts on the gut microbiome (Absoud et al., 2011; Bento & Dias, 2017; Kellert, 2002; Lee et al., 2020; Santer et al., 2007; Sobko et al., 2020; Thomas & Harding, 2011). Most studies outlining the benefits of outdoor play do not differentiate between organized or structured activities, and outdoor free play (OFP). Based on the recent Play, Learn, and Teach Outdoors—Network (PLaTO-Net) consensus definitions for outdoor play and free play (Lee et al., 2022), OFP can be understood as play that is unstructured, self-directed and takes place outside. Participation in OFP, also known as spontaneous or unstructured outdoor play, is believed to have a more holistic profile of benefits when compared to outdoor play alone, including enhancements in self-esteem, autonomy and confidence (Bento & Dias, 2017; Clements, 2004; de Valk et al., 2013). Additionally, while structured or adult-led activities are often associated with financial and time costs for families (e.g., activity fees, adult supervision time, transportation time), children can engage in OFP without cost and in almost any setting. This potentially supports play equity (Neumark-Sztainer et al., 2003) although other cultural factors may affect whether this potential is actualized. As such, a deepened understanding of the facilitators and barriers to OFP could provide important data to guide policies, as well as neighbourhood- or family-level interventions to enhance OFP opportunities.

The current literature on OFP contains much diversity regarding definitions, operationalizations, and measurement approaches, as well as a predominant focus on physical play. A best-practice approach to measure OFP has not yet been developed, making it difficult to compare research findings across studies. This paper considers the existing literature and provides timely insight into the considerations for OFP measurement approaches. The aim of this scoping review was to evaluate approaches that have been used to measure OFP and to make recommendations for OFP measurement in future research.

Current Challenges in Outdoor Free Play Research

Location: Children's OFP can originate from community settings (e.g. parks, streets), including the home, or can be based within organizational settings such as school, child care or recreation programs. While organization-based OFP can provide children with choice and autonomy on how to spend their outdoor time within certain parameters, it is common for activities to be prescriptive or organized (e.g. gym class or recess time) or set within a larger program or agenda. This diverges from unstructured free time for children to make their own play choices (Canadian Public Health Association, 2019). It is challenging to draw the line between outdoor play and what may be OFP when it occurs in organizational settings due to these programmatic elements. In contrast, home- and community-based outdoor play is easier to identify as OFP. Due to this, this paper focuses on home- and community-based OFP and excludes play occurring in organizational settings.

Measurement: Many research studies consider OFP as a proxy for physical activity, and use the term, outdoor active play (Alexander et al., 2014; Lundy & Trawick-Smith, 2021, Veitch et al., 2010). This approach overlooks the value of play activities that may be more sedentary (Herrington & Brussoni, 2015). Another common component in existing literature is the use of parents as proxies through questionnaire measures. These instruments may have reduced validity for the measurement of OFP due to second-hand reporting, and are often not explicit with respect to differentiating between structured and unstructured play. Further, OFP can have different characteristics at different developmental stages (Hughes, 2010), and even not be called play at later ages (e.g., "hanging out" for youth). Other studies, particularly those in structured settings, such as child care centres, have measured outdoor play through typologies that categorize observed play behaviour (Fjørtoft & Sageie, 2000; Loebach & Cox, 2020). Such tools evaluate play in a specific location and during a specific episode, rather than understanding overall levels of engagement in OFP for a particular child. The act of overt observation may also impact children's play choices and be logistically challenging in a community context.

Without precise definitions and measurement strategies for OFP, the ability to produce valid and comparable research on its antecedents and outcomes is impaired, as well as the evaluation of any interventions to increase participation. One methodological review (Bates & Stone, 2015) sought to identify commonly used approaches to measure outdoor play and independent mobility in children and youth.

They highlight the heterogeneity of study designs and measurement tools and the lack of a standardized methodological approach. The authors found that questionnaires or surveys were used most frequently to measure children's outdoor play and independent mobility (62.5%). However, their review did not differentiate between outdoor play and OFP. To our knowledge, this is the first review that aims to provide an overview of existing OFP measurement approaches, recognizing the distinct nature of OFP from other structured outdoor play opportunities.

Method

A scoping review was selected as the appropriate method for exploring the application of OFP measures within the existing literature due to the systematic nature of paper identification, where systematization, transparency and reproducibility of scientific evidence are prioritized, and the feasibility of canvassing multiple literature sources (Grant & Booth, 2009). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist was used for this review (Tricco et al., 2018). We used the protocol outlined by Arksey & O'Malley (2005) and Levac et al. (2010) to guide the scoping review (Arksey & O'Malley, 2005; Levac et al., 2010), and consisted of six stages:

1. Identify the purpose and research question
2. Determine database, sources and scope of review
3. Study selection
4. Chart and extract data
5. Complete numerical and thematic analyses to summarize and report results
6. Identify findings and undergo consultation

Two reviewers (MO and RR) assessed relevant studies derived from the search strategy and determined inclusion within this study. MO and RR extracted all data from the final full texts selected for inclusion and reviewed extracted data for accuracy.

Scoping Review Question

The research question was constructed using the elements of Population, Concept and Context (PCC), as recommended by the Joanna Briggs Institute (Peters et al., 2015). The studied population was children aged 2 to 17 years, the concept was OFP and the context was unstructured environments. Therefore, we developed the following research question: "What approaches are used to quantitatively measure OFP among children aged 2 to 17 years in unstructured outdoor environments?"

Definition

OFP is defined as unstructured, self-directed play that takes place outside (Lee et al., 2022). This means that, within limits appropriate for the child's stage of development, the child/ren can determine or co-determine what they do, where they go, and with whom. We focus on home- and community-based OFP rather than organization-based free play due to the latter occurring within structured contexts. The age range of 2-17 years was selected to allow the examination of approaches across childhood. The under-2 age range was excluded as outdoor play at this age is often reliant on close adult supervision, participation or direction, which would negate the definition of OFP used in this study. The upper age limit of 17 was chosen as the study focuses on childhood and 18 years is the Federally defined age of adulthood in Canada. These definitions provided a foundation to determine eligibility criteria, as shown through the inclusion and exclusion criteria below.

Inclusion Criteria

Studies were included if they met the following criteria:

- the reported methodology assesses individual outdoor play within at least one the following parameters:
    - assessment of OFP
    - assessment of outdoor play that does not explicitly include structured activities
- the outdoor play methodologies included children aged 2 to 17 years;
- the outdoor play methodologies were administered in unstructured environments (e.g., home, community);
- the outdoor play methodologies assess occurrence, frequency and/or duration of outdoor play participation; and,
- the paper included an application of the methodology resulting in empirical findings.
- there were no publication date restrictions

Exclusion Criteria

Studies were excluded if they met the following criteria:

- the reported methodologies assess outdoor play within at least one of the following parameters:
    - assessment of outdoor play combines structured activities and free play
    - assessment of a specific type of outdoor play (e.g. dramatic play, active play, etc.)
    - assessment of a location-specific type of outdoor play
    - assessment of outdoor play in an organizational, structured setting (e.g., school, child care, recreation program
    - assessment of games or activities
- there is insufficient information to determine how outdoor play was measured;
- the outdoor play methodologies assess only content, quality, perception or allowance of outdoor play;
- the study is not freely available in full text, including conference abstracts where the full-text article cannot be located (even with author contact);
- the study is not available in the English language; and,
- the study is a systematic review.

Search Strategy

The electronic databases Embase, Medline, PsychInfo and Web of Science were searched in May 2022 to identify all eligible studies. The Boolean operators "AND" and "OR", as well as the Boolean operators for proximity searching, were used to enhance the search strategy through several combinations. The following primary concept search phrase was constructed: ("play" OR "playing" OR "playtime") within five words of ("outdoor*" OR "outside" OR "out-of-school" OR "out-of-home*" OR "yard*" OR "garden" OR "gardens" OR "street*" OR "playground*" OR "playscape*" OR "park" OR "parks" OR "neighbo?rhood*" OR "natur*" OR "forest*" OR "city" OR "cities" OR "built environment*" or ("out*" within three words of (home or school or play))). This was combined with AND searches for ("measure*" OR "record*" OR "data" OR "variable*" OR "baseline*" OR "observ*" OR "report*" OR "self-report*" OR "parent-report*" OR "survey*" OR "questionnaire*" OR "log" OR "cross-sectional" OR "longitudinal" OR "associate*") AND ("child*" OR "teen*" OR "adolescen*" OR "youth*").

Medical Subject Headings (MeSH) terms for each of the search words were included when applicable, and a staff librarian was involved with the search strategy and implementation. The search strategy considered results from all geographic areas and publication dates. In addition, a comprehensive

reference search was performed, and gray literature was searched via OpenGrey, ProQuest, Des Libris and IGO Search. Additional studies and grey literature were identified through a call-out for relevant articles within the authors' networks. Further information on the search strategy can be found in Appendix 1.

Study Review and Selection

Articles from the search strategy were uploaded to Covidence (https://www.covidence.org/), a technology platform for the production and use of systematic reviews, and were screened by two reviewers (MO and RR). Each article underwent abstract and full-text screening by both reviewers. The process of article selection followed the Preferred Reporting of Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Figure 1) (Moher et al., 2015). The eligibility criteria previously outlined were used to screen articles for inclusion. Differences in inclusion decisions between reviewers were flagged and discussed, and a final decision was agreed upon. If a conflict on an inclusion decision remained, a third reviewer (EO or MB) was tasked with resolving the conflicts.

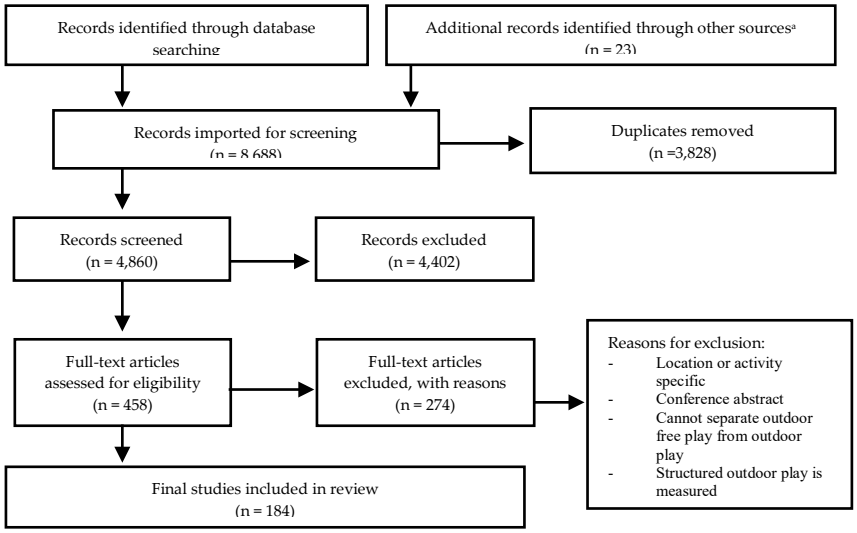
Abstracts were removed if they did not meet the eligibility criteria, were duplicates, or if the full-text could not be located even after contacting the lead author. Conference abstracts identified by the search strategy were compared to returned papers and authors were contacted by email if no corresponding paper could be identified. A full-text review involved reviewing articles in full and determining further eligibility. Guided by the inclusion and exclusion criteria, final studies were identified as being relevant to our research question and were included in the review. Data extraction was conducted by two reviewers (MO and RR) independently.

Data analysis focused on the characteristics of studies, the measurement tools used and the themes derived from the measurement strategy limitations. Information was organized systematically into data tables developed by the primary authors (MO and RR). Thematic analysis was performed to understand the play typologies and measurement tools from the selected articles.

Results

Overview of Selected Studies

The electronic search strategy returned a total of 8,665 records. In addition, 23 articles were identified within the grey literature and through a call-out for relevant studies within the authors' networks. Using the key search descriptors, 4,860 articles were identified, after the removal of duplicates, and reviewed. Many abstracts were excluded for reasons including but not limited to using 'play' as a verb, measuring outdoor play in structured settings, or measuring a specific sub-type of outdoor play, such as 'active play'. At the full-text review process, 458 articles were assessed for eligibility (Figure 1).



[a] Other sources included grey literature search results and studies received from network calls for our consideration.

Figure 1. PRISMA flow diagram for article selection

Characteristics of included studies

This scoping review yielded 184 articles from 51 countries, mostly located in the Global North. Included articles represented a variety of study topics, with most collecting data from children in the early years (0-6 years) or primary school years (6-12 years). The first identified paper was published in 1934. Table 1 and the sections below provide an overview of the characteristics of the final included studies. All included studies are outlined in Appendix 2.

Table 1. Characteristics of included OFP review studies (N=184)

Characteristics	Sample Group	N	%
Continent of study location	Africa	4	2.2%
	Asia	26	14.1%
	Australia	17	9.2%
	Europe	76	41.3%
	North America	54	29.3%
	South America	7	3.8%
	Unknown*	2	1.1%
Publication year	Pre- 2005	12	6.5%
	2005 – 2009	13	7.1%
	2010 – 2014	46	25.0%
	2015 – 2019	61	33.2%
	2020 – 2022[a]	52	28.3%
Variable Type	Covariate	28	15.2%
	Exposure	65	35.3%
	Outcome	91	49.5%
Target age range[b]	2 – 5 years	116	63.0%
	6 – 12 years	129	70.1%
	13 – 17 years	42	22.8%
Respondent	Parent/Guardian	136	73.9%
	Child[c]	27	14.7%
	Both (jointly)	10	5.4%
	Both (separately)	2	1.1%
	Differentiated by child age	9	4.9%
Measurement method	Questionnaire	168	91.3%
	Logbook	16	8.7%
	Interview[d]	1	0.5%
Outdoor play measured in	Occurrence only[e]	4	2.2%
	Frequency[f]	30	16.3%
	Duration	103	56.0%
	Frequency and duration	42	22.8%
	Unknown[g]	5	2.7%

[a]Up to May 2022
[b]Papers can be included in multiple age group categories as some studies spanned different age ranges, therefore the percentages do not equate to 100%.
[c]Includes one paper where adults recalled their childhoods
[d]Categorized as an interview if delivered by a researcher and explicitly semi-structured or unstructured.
[e]Frequency and/or duration data can also be used to calculate OFP occurrence
[f]Categorized as a frequency measure when frequency information is explicitly recorded (e.g. 'how many days a week does your child play outside') rather than implied (e.g. 'how much time does your child spend playing outdoors daily').
[g]Details not provided within the paper

Geographic Region

Of the final included articles, 76 (41.3%) studies were conducted in Europe and 54 (29.3%) studies were conducted in North America. There was a notable paucity of literature from Africa and South America (Table 1). The majority of studies included in this review collected data in the United States (21.2%), Australia (9.2%), Canada (8.2%) or Germany (6.5%).

Publication Year

The majority of studies (61.5%) were published in the past 8 years (Table 1). Of these, 28.3% were

published between Jan 2020 and May 2022. Within our final included studies, few articles (6.5%) assessed OFP prior to 2005.

Target Population (Respondent and Sample age group)

Participants within the selected articles crossed a range of age groups. While most studies had small or targeted ages of children, other studies had broad age groups that crossed multiple stages of a child's life. Children in the early years were represented in 63.0% of included studies and children of primary school age were represented in 70.1% of studies (Table 1). Approximately 13.0% of the studies focused on all years that a child attends formal school (i.e., 6 – 17 years). Only 22.8% of studies had sample populations of children over the age of 12 years, and among those that included youth, most focused on those aged 13 to 14 or studied a broad age range (i.e., 0 – 17 years).

Of all included studies, 73.9% exclusively used parent-report measures to assess children's OFP (Table 1). Only 14.7% of studies relied solely on child-report to measure OFP (Table 1) and these included children aged 6-17 years (Table 2). Many of the measures administered to caregivers and children while together (5.4% of the total) were conducted during a hospital or clinic visit. Among studies that examined older children aged 13-17, the use of parent-report was slightly more common (Table 2).

Table 2. Measurement tool respondent by target age group among included OFP review studies

Measurement Tool Respondent	Target Age Group n(%)		
	2-5 years	**6-12 years**	**13-17 years**
Parent	104 (89.7%)	81 (62.3%)	15 (35.7%)
Child	0 (0.0%)	27 (20.9%)	11 (26.2%)
Both	12 (10.3%)	21 (16.3%)	16 (38.1%)
Total	**116**	**129**	**42**

Study Topic and Aim

There was variance in the primary topics studied within the final article selection. The three largest primary study topics were physical activity (29.9%), play (outdoors or otherwise) (29.3%) and weight/obesity (17.4%). Other movement-based topics included sedentary behaviours (2.7%) and independent mobility (2.7%). Almost half (49.5%) of included studies had OFP as an outcome variable within the study (Table 1), often with OFP providing a measure to support a physical activity outcome variable. These studies measured OFP as a result (outcome) within their study, whereas other studies measured OFP as an associated or confounding variable within their analysis (covariate) or a predictor variable that may be associated with an outcome (exposure). While there was a clear focus on children's physical health, not all were connected to movement and activities. A small number of studies focused on environmental risks, such as blood lead concentration (3.3%), vitamin D exposure (3.3%), ocular health (1.1%), pesticide exposure (1.1%), and parasite transmission (0.5%), using OFP as a proxy for levels of potential exposure. Other studies measured OFP as a variable related to other aspects of children's health, such as traffic-related injury, atopy, mental health and constipation.

How was Outdoor Free Play Defined?

Within the included studies, a range of terms and definitions were used to identify OFP. The word stem 'play' (e.g. playing, playtime) was used in all variable descriptions with the exception of one study which just referred to 'time'. 'Outdoor' and 'outside' were used interchangeably among most OFP terms used, however, some studies used 'out-of-home' (1.1%) or had no mention of the outdoors (3.8%) within their OFP terminology. The most variation was seen in relation to the term 'free'. Only 9.8% of the papers included a term in their play variable description relating to the play being free, such as free, unstructured, unsupervised, unorganized, spontaneous or independent. The most commonly used terms were 'outdoor play' (39.1%), followed by 'playing outdoors' (14.1%) and 'playing outside' (12.0%). OFP was the most commonly used term specific to free play, but this was only used in 2.7% of the studies. Most studies

included in the review did not provide information on the descriptors, contexts or characteristics of the OFP variable that was being measured. The studies that included descriptors, contexts or characteristics of OFP outlined factors related to the setting and location (Berglind & Tynelius, 2018; de Macêdo et al., 2022; Loucaides & Tsangaridou, 2017; Nordbakke, 2019; Saldanha-Gomes et al., 2017; Veitch et al., 2009), the time, day or season (Adams & Prince, 2010; Dodd et al., 2021), the organizational component of the activity (Andrejewski, 2011; Deforche et al., 2009; Page et al., 2010; Surdu et al., 2006), and excluded activities (Balcerek et al., 2017; Goodman et al., 2012; Hammond et al., 2011; Loucaides & Jago, 2006; Remmers et al., 2014). Studies also asked multiple questions related to outdoor play, separating out structured activities and sport activities in a separate question to OFP (Deforche et al., 2009; Goodman et al., 2011; Hammond et al., 2011). Through a process of elimination, this provided insight into the authors' understanding of the type of play or activity they intended to measure.

How was Outdoor Free Play Measured?

A variety of approaches were used to measure OFP (see typology in Appendix 3). Methods captured within this review were predominantly questionnaires (91.3%), followed by logbooks (8.7%) and interviews (0.5%). There was variability in how some measures were administered based on setting, including the use of tools originally designed as a pen and paper questionnaire being adapted based on data collection procedures. For example, one study (Xu et al., 2016) administered the *Outdoor Playtime Recall Questions* (Burdette et al., 2004) via face-to-face interviews with parents. For the purposes of this classification analysis, structured measures with quantitative or closed response options were categorised as questionnaires.

Studies measured OFP using frequency, duration or occurrence measures. Duration measures were used most frequently to measure OFP (56%), followed by combined frequency and duration measures (22.8%), frequency only measures (16.3%), and occurrence only measures (2.2%). These variables demonstrated a 'stacking' nature, as a measure of occurrence could become a measure of frequency if completed over sequential days, and likewise, a measure of duration could become a measure of frequency and duration. All measures of frequency and/or duration were also measures of occurrence. Measures of occurrence were most often captured through a dichotomous variable (yes/no), asking if a child participates in OFP. Frequency was commonly measured as the number of days per week a child participates in OFP captured via categorical options, a continuous variable (open-ended) or a Likert scale. Some studies (Balcerek et al., 2017; Grammatikopoulou et al., 2018; Husmann et al., 2017; Silva & Santos, 2017) had response options for how many 'times' per week OFP occurred rather than number of days, and others primarily focused on number of times but also included a 'daily' option (Ferrao, 2015; Ferrao & Janssen, 2015; Janssen, 2015; Nordbakke, 2019; Parent et al., 2021). Duration was captured through the use of continuous or ordinal response options and was most commonly measured as the number of minutes per day. Studies that measured a combination of frequency and duration often asked for the number of days per week, and the number of minutes per day, that a child participated in OFP (Appendix 3).

Within the reviewed articles, two additional variables were identified to guide participants' responses for frequency, duration and occurrence. First, participants were primed to respond based on actual events (common with logbook methods and in some questionnaires); based on what was typical/usual; or based on an average. Second, sometimes participants were given a timeframe as a reference period, such as the previous week, a weekend, a week within the last month, or a specific season. However, no reference period was given for most studies. Measurement approaches also varied in the number of data responses required from each participant. Two or more data inputs were typically requested in studies that examined seasonality, examined weekdays separately from weekends, or used logbook methods that spanned several days A typology of these measurement approaches for the included articles, separated by target respondent and data gathering method, is provided in Appendix 3.

Which measurement tools were used to measure outdoor free play?

Almost half of all included studies (48.1%) developed their own questionnaires or measurement approaches to capture children's OFP (Appendix 3). Of those using existing and unmodified measures, the

most common measurement tool was the *Outdoor Playtime Recall Questions* developed by Burdette et al. (2004) (10.8%) which was applied to children aged 0-12 years. This tool quantifies weekly outdoor play time using questions previously shown to correlate with physical activity levels measured through accelerometers in preschoolers. There are two questions for the parent, one recalling a typical weekday and the other a typical weekend day in the past month, asking for the time spent outdoors playing in hours and minutes (Burdette et al., 2004). Also frequently used was the *MoMo Physical Activity Questionnaire* (6.1%), which was originally developed in German and uses 28 items and measures to understand the frequency, duration and intensity of physical activities, including outdoor play, in a typical week. This tool seeks to capture habitual activity and has been shown to have acceptable test-rest reliability for children aged 4-17 years (Jekauc et al., 2013). The tool is typically used as a child self-report tool for children aged 11 and older; children under the age of 11 typically complete the questionnaire with the help of their parents. Previous research found that the MoMo-PAQ was weakly correlated with accelerometry data (Jekauc et al., 2013).

The *Children's Play Scale* (Dodd et al., 2021) (2.2%) was another common measure and assesses the frequency of children's play in seven locations and the length of time at each place. Parents are also asked to report on seasonal differences in play behaviour for each of these locations. The seven indoor and outdoor locations include: At home or in other people's homes; outside at home or at other people's homes (e.g., garden/yard/balcony); at a playground; in trees/forests/woodland/grassy spaces (not including the garden at home or other people's homes); in the street or public places close to home; outdoors near water (e.g., at the beach, in the sea, near a river, lake or cliffs); indoor play centres and pools (e.g., soft play, trampoline parks, swimming pools, etc.). The *Canadian Health Behaviour in School-Aged Children (HBSC) Questionnaire* (Freeman et al., 2016) (1.1%) was the final measure that was used in more than one study. It collects data on school-aged children aged 11 to 15 years to understand health attitudes, behaviours and lifestyles. Survey items are continuously updated, validated, and pilot-tested. The HBSC includes one outdoor play question – 'How many hours a day, in your free time, do you usually spend playing outdoors outside of school hours?' – with nine response options including none at all; About half an hour; About 1h, About 2h, About 3h, About 4h, About 5h, About 6h, About 7 h or more.

Measurement limitations

Some common limitations were evident among the authors who reported them. Limitations were related to the study design, the target participant sample, the way in which the data were transformed, the measurement tool and the survey response options (Table 3).

Table 3. Study and measurement limitations, as stated by authors among included OFP review studies

Limitation Area	Limitation Detail
Participants and Respondents	• Parents may have encouraged the child to play more during the study • Parents with children in child care, or who are less aware of their child's activities outside of the home, may know less about their child's play behaviour and therefore underestimate their child's OFP (misclassification/measurement error) • Parents may overreport their child's OFP due to social desirability (social desirability bias) • Parents may have challenges remembering their child's OFP behaviour and time (recall bias) • Younger children may not be able to accurately report their OFP using traditional survey approaches • Respondents who choose to respond to surveys may be naturally more proactive in encouraging their child's OFP and/or have healthier lifestyle habits (respondent bias) • Challenging for parents to quantify OFP among younger age groups due to play often being supervised and/or facilitated. • Sample only includes those who speak English and are able to understand and respond to survey questions
Data Transformation	• Ordinal response categories may not fully represent the range of children's OFP (ceiling effect) • Dichotomization (loss of information and reduced statistical power) • Cumulative totals could not be calculated for categorical and some ordinal measures
Measurement	*Measurement Tool* • The order of questions asked may influence response effects • Retrospective self-report can lead to recall bias • Tool developed within a local context may not be generalizable to other populations

- Tool developed previously may now be dated and/or has not been validated recently
- Tool has not been validated, or has not been validated with the target group

Survey Question on Outdoor Free Play

- Frequency, time or intensity of OFP was not assessed, only the occurrence of outdoor free play (presence/absence)
- The assessment timeframe was too specific (e.g. only one day, or only weekdays)
- The assessment timeframe was too broad (e.g. the past month, or no timeframe given)
- Respondent was asked to report on OFP within a given geographic region (e.g. neighbourhood) which does not encompass all OFP
- Assessment of time spent in OFP does not consider play quality
- Question does not consider differences in seasonality, climate or weather.
- Question does not address differences between OFP and outdoor recreation
- Question prompts respondents to think of active outdoor play and does not consider other unstructured activities (e.g. reading; listening to music) and could be considered OFP
- Question may be interpreted differently by respondents as 'time in play' was not operationalized for participants
- Respondents were not asked to differentiate children playing alone from children participating with or receiving direction from an adult.

Discussion

This scoping review is the first comprehensive overview of measurement tools to assess OFP among children aged 2-17 years. The results of this study demonstrate that there is a large amount of literature available on this topic, with 184 articles that were identified and included in the final study sample. Among these, 75.5% collected data in Global North countries, 47.3% focused on physical activity or obesity study aims and 91.3% of studies used a questionnaire to measure OFP. The number of included articles in the final sample is reflective of the limited number of studies that considered child autonomy in the measurement of OFP.

Less than 10% of included studies explicitly focused on OFP. This constrains the progression of research in considering OFP as distinct from physical activity, outdoor play and other forms of outdoor activities. As research has shown, OFP provides benefits that cannot be addressed through structured outdoor play opportunities, including benefits to cognitive, physical and social-emotional development, as well as physical health (Absoud et al., 2011; Bento & Dias, 2017; Kellert, 2002; Lee et al., 2020; Santer et al., 2007; Sobko et al., 2020; Thomas & Harding, 2011). In addition, children's OFP requires unique considerations for how it can be supported, including the role of adults, and how OFP may differ across seasons, locations and developmental stages. To further research on children's OFP, this review outlines important evidence on how OFP is measured within the existing literature and recommendations on measurement in future studies.

Measurement Tool Themes

Outdoor Free Play as a Proxy for Physical Activity

Half of the studies focused on physical activity, sedentary behaviour or weight management (50.0%). Within most of these studies, OFP measures were used as a proxy for physical activity, in particular among younger age groups. One of the most utilized tools was Burdette et al.'s (2004) *Outdoor Playtime Recall Questions*, a parental-reported measure of children's outdoor playtime as a measure of physical activity. This study emphasized that physical activity in preschool-aged children usually occurs during free play, rather than in structured activities. However, not all play is physically active and therefore, this only captures a portion of activities and does not consider the other benefits of OFP, such as peer relationships or social functioning (Herrington & Brussoni, 2015).

Proxy-report of Children's Outdoor Free Play

For most studies, children under age 7 were not perceived as having the cognitive ability to report on their own outdoor play (Burdette et al., 2014), necessitating parent-report. Limitations associated with relying on parent recall include the potential for recall bias and social desirability bias (Reimers et al., 2019;

Shephard, 2003). In fact, a previous study by Jayasuriya et al. (2016) found that over one-half of the parents in their study did not know the amount of time their child played outside at child care each day. Likewise for play at home, Veitch et al. (2009) showed low reliability in parent proxy reporting to capture the amount of time children spend in a given play behaviour. Children may participate in concurrent activities, such as cleaning up, making proxy-reports challenging (Hinkley et al., 2012). In physical activity research, parents often report more activity than when objective measures are used (Colley et al., 2012), indicating a potential social desirability bias.

Another common limitation was that most studies did not report who was responding on behalf of the child. Among studies with parent respondents, only 6.0% reported that mothers were specifically targeted to report on their child. All other studies did not identify if there were considerations for response differences by fathers, mothers, grandparents or other caregivers. Previous studies have reported that parental reports of child behaviour differ between mothers and fathers (Davé et al., 2008; Luoma et al., 2004). Studies using this approach assumed that parents were either present in the home and closely monitoring children, or were in communication with the child or another person about these patterns. In the 9.8% of studies where parents and children jointly responded to the data collection instrument, it was unclear whose voice was given priority or how any discrepancies in perspective were resolved.

For studies that rely on proxy reporting, it is generally recommended that all caregivers be included to enhance the accuracy of reporting (Eiser & Morse, 2001). Further, including children's perspectives of their play can provide unique insights, as long as measurement strategies are appropriate to the developmental stage of child respondents. While 25.5% of included studies in this review gathered information from the child in some manner, over three-quarters of the studies did not utilize opportunities to engage children in the reporting process. As OFP is based on the requirement that adults not be involved in directing children's play, relying on parent-report to assess this measure may be problematic.

Retrospective Questionnaires

Retrospective questionnaires were used in almost all studies. Retrospective questionnaires are common tools and can facilitate quick, flexible and easy approaches to capturing OFP through a single question. However, there are vast limitations to relying on retrospective recall to provide valid results (Schwarz & Oyserman, 2001). Responding to even the simplest question involves complex cognitive processes, (Piasecki et al., 2007; Schwarz & Oyserman, 2001), creating opportunity for error. In addition, retrospective self-report often relies on estimation or a quick 'count' of occurrences or timing. In the case of parents or children responding on OFP frequency and duration, there is inevitably error within these tools. Direct measures can help with the assessment of OFP, such as GPS devices, however, they are more resource-intensive and the trade-offs need to be considered in the context of the research question.

Structured Settings

Definitions or operationalizations were rarely provided that would indicate if the study made a clear distinction between structured and unstructured activities. When these distinctions were evident within a measurement tool, the location was also measured to indicate if a structured setting was examined. For example, Sarker et al. (2015) included three measures of unstructured, free play: during child care/school, during the preschool program/daycare, and outside of child care, preschool, school or daycare, which made it possible to separate OFP according to the definition outlined within this review. Some studies that used the *Outdoor Playtime Recall Questions* (Hinkley et al., 2018; Nathan et al., 2021; Wosje et al., 2010) used multiple settings to capture OFP information, without differentiating between structured and unstructured activities, making it difficult to know if the measure included sports or other physical activities. Some authors demonstrated that they were cognizant of the differences between OFP and outdoor play by including a robust definition of OFP (Stracciolini et al., 2022; Wijtzes, Jansen, et al., 2014) or adapting existing measurement approaches to accurately assess OFP (Grigsby-Toussaint et al., 2011; Janssen, 2015).

While not included in our final sample, many studies operationalized the *Outdoor Playtime Checklist* (Burdette et al., 2004), a tool that is distinct from the *Outdoor Playtime Recall Questions* measure, which was

included in the same research (Burdette et al., 2004). Studies that used the *Outdoor Playtime Checklist* (Burdette et al., 2004) were excluded from this review as this tool explicitly includes outdoor play while at daycare or preschool. Studies that purposefully excluded child care, school, or other structured settings were included in this review, assuming all other inclusion criteria were met. For example, one study (Lumeng et al., 2017) mobilized the *Canadian Health Measures Survey* (Tremblay & Gorber, 2007), which specifically addressed unstructured free play by asking parents, 'aside from time in daycare and pre-school, on a typical weekday, how much time does your child spend outside in unstructured free play?' Of note, outcomes such as risky play and nature play were often researched in connection with OFP but were typically excluded from our review because the research was based in education settings.

Considerations for Future Measures

Prioritizing Children's Agency

The United Nations Convention on the Rights of the Child states that children have the right to form their own views and to express those views freely (United Nations General Assembly, 1989). However, research has historically prioritized adult perspectives to capture children's information (Clarke, 2015; Malone & Hartung, 2010). This is exacerbated with young children, where researchers perceive data collection as more challenging or time-consuming, or they underestimate children's competence to capture accurate data (Clarke, 2015; Powell & Smith, 2009). In particular, methods that require verbal or written responses are often perceived as not suitable for children under six. This was evident within this review as most studies did not engage children in their methodology, particularly younger children.

To reflect the understanding that children's agency is key to their OFP behaviours, different approaches are needed to support data collection participation from a variety of age groups, such as participatory research approaches that include the child and measurement tools that do not rely on written responses. Joint measurement tools that involve both the parent and the child are preferred if parent perspectives are desired, with the parties providing separate or sequential data. In addition, instruments beyond interviews and surveys may better support children's participation. Measurement approaches that are age-appropriate and involve multiple data collection strategies are most successful when including children as research participants (Christian et al., 2010). Children are most likely to participate in data collection when instruments include opportunities to be active and express themselves, including photography, storytelling, and using software and digital tools (Larsson et al., 2018).

Supporting Participant Responses

For parent recall survey measures, consideration of methods and opportunities to increase participants' recall of their children's OFP is needed, such as shortened reference periods, using personal and tangible indications such as examples of OFP activities, and reducing the influence of social desirability on participants' responses. Selecting an appropriate recall period can reduce recall bias (Althubaiti, 2016). Additional methods, such as diaries or interviews, could also be used to reduce measurement error (Cramer et al., 1993). Diaries would capture day-to-day activities, and interview responses could be supported by prompts that assist recall. Furthermore, social desirability bias can be reduced by ensuring the questionnaire is validated before implementation (Althubaiti, 2016).

Clear wording and consideration of possible interpretations can help avoid misinterpretation. For example, studies measuring the number of times each week children participated in OFP (Balcerek et al., 2017; Grammatikopoulou et al., 2018; Husmann et al., 2017; Silva & Santos, 2017) did not specify if these 'times' had to occur on different days. It was unclear whether researchers sought to capture discrete episodes of OFP regardless of the day of occurrence, yet some studies included a 'daily' option (Ferrao, 2015; Ferrao & Janssen, 2015; Janssen, 2015; Nordbakke, 2019; Parent et al., 2021).

Assessing Across Different Days, Time-Points and Seasons

Many surveys assessed OFP by asking participants to recall an average or typical day (Dodd et al., 2021; Handal et al., 2007; Kocken et al., 2012; Sum et al., 2022). This can be problematic if there is no clear

definition of what is considered a typical day. For example, some participants may consider a typical day to be a weekend spent outdoors with family, while for others it may be a weekday where children are cared for by grandparents after school. In addition, consideration of the time of day, weekends or weekdays, and seasons, may alter the way in which participants report OFP. Seasonal variation of children's physical activity, movement and behaviours occurs regardless of region (Carson & Spence, 2010). These aspects need to be taken into consideration in measurement tools, with explicit decisions made on how to address these normal variations. Outlining time framings and reference periods can produce more specific measurement questions, as seen within this review (Chung et al., 2021; Rodriguez-Ayllon et al., 2020; Wijtzes, Bouthoorn, et al., 2014; Wijtzes, Jansen, et al., 2014).

Further Defining The Parameters of Outdoor Free Play

Within this review, we used the concept of child autonomy in play as an indicator of OFP rather than child choice. The latter allows children to select from different options for play, the former allows them to be self-governing. A conceptualization of free play which focuses on children's choice instead of child autonomy could allow for free play to take place within organized settings, such as recess or after school clubs, as set out by Lee et al. (2022). Conversely, even in unstructured conditions, children's time and opportunities for play will have parameters. For example, a parent may set the available timeframe for play, and opportunities may be shaped by the affordances in the physical and social environment. For the field of OFP to progress, these various conceptualizations will need to be further understood. An important part of the distinction between choice and autonomy may come down to the extent to which outdoor play is supervised by an adult. This would have implications for the developmental stage at which outdoor free play (away from the supervision of an adult) becomes possible.

Strengths & Limitations

To our knowledge, this is the first review to examine the measurement of children's OFP. In addition, the scope of the search included all geographic regions and any year of publication. This review considered a large age range of children, encompassing early and middle childhood as well as adolescence. The depth of the literature scoped is reflective of the large number of studies that were assessed to create a comprehensive final sample. This review examined multiple methodological and measurement considerations in the assessment of children's OFP. A strength of our findings is the significant detailed limitations brought forward on the existing validated instruments and original tools currently used in this area of research.

A methodological limitation of this review was the restriction of studies to the English language, which may have reduced the geographic and cultural scope of included studies. However, over 50 countries were assessed indicating a diverse geographic range. Another limitation is the unique definition and eligibility criteria used to assess measures of OFP. Although many considerations went into creating eligibility criteria that excluded structured settings and forms of play, the inclusion criteria included all studies that did not explicitly state that structured activities or settings were present. Therefore, it is not possible to know if all structured forms of outdoor play were fully excluded from the final articles. Using a definition of OFP based on expert opinion to determine inclusion criteria, supported our decision to consider this a valid approach to determining eligibility of studies.

Implications

There are important implications based on the findings of this scoping review. First, the range of research topics that utilize a measure of outdoor play, each with differing empirical needs and resources, suggests that a suite of tools should continue to be used for future research. Recommending just one measurement approach is unlikely to meet the needs of all research endeavours. Second, further consideration of the differences between play types (e.g., OFP vs play-based physical activity) can support the choice of measurement approach. Third, an important implication of this review is the knowledge that specific measurement methods, separate from measuring physical activity and structured play, are required to assess children's OFP. Multiple validated measurement approaches are available for many

other indicators of children's health and behavior. Future OFP research must prioritize the creation of validated instruments that accurately capture children's OFP. This requires innovative ways to support participant recall, engage children in data collection and accurately assess OFP across different time periods, locations and seasons.

The findings from this review also revealed a lack of standard terminology regarding OFP and that the parameters of structured and unstructured settings can be challenging to untangle. The recent international consensus definition work by Lee et al. (2022) conceptualizes and defines play to help harmonize the international research community. To understand how adult supervision and direction may influence and shape OFP, there needs to be an understanding regarding the nature of supervision. Current literature conceptualizes supervision based on different considerations, including distance from the child, whether the supervision is carried out visually or audibly, and whether it is continuous or periodic (Morrongiello & Cox, 2020; Saluja et al., 2004). The child's developmental stage must also be considered in defining appropriate supervision. For younger children who require supervision to participate in outdoor play, we must consider ways in which autonomy in play can be maintained. More research is required to understand the nuances between play choice to play autonomy and how play autonomy can be supported along developmental stages, which will inevitably influence measurement approaches.

Conclusion

This review outlines the current state of measurement to understand and assess children's OFP and provides measurement considerations and recommendations for future research. With a recent exponential increase in OFP-related research, it is imperative that studies use accurate, valid, reliable and practical approaches to measuring this variable, as well as consistent approaches that would facilitate comparison across studies, populations and settings. In addition, future measurement tools must prioritize child autonomy in play as an indicator of OFP to effectively capture the true nature of free play. Existing tools could be modified or supplemented to focus on OFP, reduce potential biases, and support the inclusion of children's perspectives and voices.

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Appendix 1. Search Strategy

Embase

1. play/
2. recreational park/
3. forest/
4. city/
5. neighborhood/
6. Built environment/
7. or/2-6
8. 1 and 7
9. ((play or playing or playtime) adj5 (outdoor* or outside or "out-of-school*" or "out-of-home*" or yard* or garden or gardens or street* or playground* or playscape* or park or parks or neighbo?rhood* or natur* or forest* or city or cities or "built environment*" or (out adj3 (home or school or play))))).tw,kw.
10. or/8-9
11. Measurement/
12. Observational study/
13. Cross-sectional study/
14. Longitudinal study/
15. Questionnaire/
16. (measure* or record* or data or variable* or baseline* or observ* or report* or "self*report*" or "parent*report*" or survey* or questionnaire* or log or cross-sectional or longitudinal or 20hinese20n*).tw,kw.
17. or/11-16
18. child*.tw,kw.
19. adolescen*.tw,kw.
20. teen*.tw,kw.
21. youth*.tw,kw.
22. or/18-21
23. 10 and 17 and 22

Medline

1. "Play and Playthings"/
2. Parks, recreational/
3. Nature/
4. Forests/
5. Built environment/
6. Cities/
7. or/2-6
8. 1 and 7
9. ((play or playing or playtime) adj5 (outdoor* or outside or "out-of-school*" or "out-of-home*" or yard* or garden or gardens or street* or playground* or playscape* or park or parks or neighbo?rhood* or natur* or forest* or city or cities or "built environment*" or (out adj3 (home or school or play))))).tw,kf.
10. or/8-9
11. "Surveys and questionnaires"/
12. Observation/
13. Cross-sectional studies/
14. Longitudinal studies/
15. (measure* or record* or data or variable* or baseline* or observ* or report* or "self*report*" or "parent*report*" or survey* or questionnaire* or log or "cross?sectional" or longitudinal or 20hinese20n*).tw,kf.
16. or/11-15
17. child*.tw,kf.
18. adoles*.tw,kf.
19. teen*.tw,kf.
20. youth*.tw,kf.
21. or/17-20
22. 10 and 16 and 21

PsychInfo

(DE "Childhood Play Behavior") AND ((DE "Recreation Areas") OR (DE "Playgrounds") OR (DE "Neighborhoods") OR (DE "Built Environment") OR (DE "Nature (Environment)") OR (DE "Urban Environments"))
OR
(TI (play or playing or playtime) N5 (outdoor* or outside or "out-of-school*" or "out-of-home*" or yard# or garden# or street# or playground# or playscape# or park# or neighbo#rhood or neighbo#rhoods or natur* or forest# or city or cities or "built environment*" or (out N3 (home or school or play)))) OR (AB (play or playing or playtime) N5 (outdoor* or outside or "out-of-school*" or "out-of-

home*" or yard# or garden# or street# or playground# or playscape# or park# or neighbo#rhood or neighbo#rhoods or natur* or forest# or city or cities or "built environment*" or (out N3 (home or school or play)))) OR (KW (play or playing or playtime) N5 (outdoor* or outside or "out-of-school*" or "out-of-home*" or yard# or garden# or street# or playground# or playscape# or park# or neighbo#rhood or neighbo#rhoods or natur* or forest# or city or cities or "built environment*" or (out N3 (home or school or play))))
AND
(DE Measurement) OR (DE Longitudinal studies) OR (DE surveys) OR (DE questionnaires) OR (TI (measure* or record* or data or variable* or baseline* or observ* or report* or "self#report*" or "parent#report*" or survey* or questionnaire* or log or cross-sectional or longitudinal or 21hinese21n*)) OR (AB (measure* or record* or data or variable* or baseline* or observ* or report* or "self#report*" or "parent#report*" or survey* or questionnaire* or log or cross-sectional or longitudinal or 21hinese21n*)) OR (KW (measure* or record* or data or variable* or baseline* or observ* or report* or "self#report*" or "parent#report*" or survey* or questionnaire* or log or cross-sectional or longitudinal or 21hinese21n*))
AND
(TI (child* or teen* or adolescen* or youth*)) OR (AB (child* or teen* or adolescen* or youth*)) OR (KW (child* or teen* or adolescen* or youth*))

Web of Science

(TI=((play or playing or playtime) NEAR/5 (outdoor* or outside or "out-of-school*" or "out-of-home*" or yard$ or garden$ or street$ or playground$ or playscape$ or park$ or neighbo$rhood or neighbo$rhoods or natur* or forest$ or city or cities or "built environment*" or (out NEAR/3 (home or school or play))))) OR (AB=((play or playing or playtime) NEAR/5 (outdoor* or outside or "out-of-school*" or "out-of-home*" or yard$ or garden$ or street$ or playground$ or playscape$ or park$ or neighbo$rhood or neighbo$rhoods or natur* or forest$ or city or cities or "built environment*" or (out NEAR/3 (home or school or play))))) OR (AK=((play or playing or playtime) NEAR/5 (outdoor* or outside or "out-of-school*" or "out-of-home*" or yard$ or garden$ or street$ or playground$ or playscape$ or park$ or neighbo$rhood or neighbo$rhoods or natur* or forest$ or city or cities or "built environment*" or (out NEAR/3 (home or school or play)))))
AND
(TI=(measure* or record* or data or variable* or baseline* or observ* or *report* or survey* or questionnaire* or log or cross-sectional or *longitudinal or 21hinese21n*)) OR (AB=(measure* or record* or data or variable* or baseline* or observ* or report* or survey* or questionnaire* or log or cross-sectional or longitudinal or 21hinese21n*)) OR (AK=(measure* or record* or data or variable* or baseline* or observ* or report* or survey* or questionnaire* or log or cross-sectional or longitudinal or 21hinese21n*))
AND
(TI=(child* or teen* or *adolescen* or youth*)) OR (AB=(child* or teen* or adolescen* or youth*)) OR (AK=(child* or teen* or adolescen* or youth*))

Appendix 2. Final Sample of Included Studies

Author(s) & Year	Title	Country	Age Range (years)	Data Collection Method
Aarts et al. (2010)	Environmental determinants of outdoor play in children: A large-scale cross-sectional study	Netherlands	4-12	Questionnaire
Aarts et al. (2012)	Outdoor play among children in relation to neighborhood characteristics: a cross-sectional neighborhood observation study	Netherlands	4-12	Questionnaire
Adams & Prince (2010)	Correlates of physical activity in young American Indian children: lessons learned from the Wisconsin Nutrition and Growth Study	United States	3-8	Questionnaire
Aggioa et al. (2017)	Correlates of children's independent outdoor play: Cross-sectional analyses from the Millennium Cohort Study	United Kingdom	7	Questionnaire
Aktas Arnas & Saribas (2020)	An investigation of pre-school children's and their parents' outdoor play experiences	Turkey	3-6	Questionnaire
Altun D. (2022)	Family Ecology as a Context for Children's Executive Function Development: the Home Literacy Environment, Play, and Screen Time	Turkey	4-5	Questionnaire
Anderson et al. (2016)	Vitamin D and Fracture Risk in Early Childhood: A Case-Control Study	Canada	0-6	Questionnaire
Andrejewski (2011)	Nature connection, outdoor play, and environmental stewardship in residential environmental education	United States	10-12	Questionnaire
Balcerek et al. (2017)	Health-Related Behaviour Among Children of Childhood Cancer Survivors in Germany	Germany	0-17	Questionnaire
Berglind & Tynelius (2018)	Objectively measured physical activity patterns, sedentary time and parent-reported screen-time across the day in four-year-old Swedish children	Sweden	4	Questionnaire
Bhuyan & Zhang (2020)	A mixed methods research strategy to study children's play and urban physical environments in Dhaka	Bangladesh	7-15	Questionnaire
Bornhorst et al. (2015)	WHO European Childhood Obesity Surveillance Initiative: associations between sleep duration, screen time and food consumption frequencies	Multiple: Bulgaria, Czech Republic, Lithuania, Portugal, Sweden	6-9	Questionnaire
Bringolf-Isler et al. (2010)	Built environment, parents' perception, and children's vigorous outdoor play	Switzerland	6-14	Questionnaire
Buchanan et al. (2021)	A Longitudinal Analysis Examining the Associations of Tummy Time With Active Playtime, Screen Time, and Sleep Time	Australia	0-2	Questionnaire
Burdette & Whitaker (2020)	A national study of neighborhood safety, outdoor play, television viewing, and obesity in preschool children	United States	0-3	Questionnaire
Burdette et al. (2004)	Parental Report of Outdoor Playtime as a Measure of Physical Activity in Preschool-aged Children	United States	3-5	Questionnaire
Caroli et al. (2011)	Physical activity and play in kindergarten age children	Multiple: Denmark, Italy & Poland	5	Questionnaire

Carsley et al. (2016)	The impact of daycare attendance on outdoor free play in young children	Canada	1-5	Questionnaire
Chesnut et al. (2018)	The Grow parenting program: Demonstrating proof of concept	United States	5-10	Questionnaire
Chia et al. (2022)	Family-focused contextual factors associated with lifestyle patterns in young children from two mother-offspring cohorts: GUSTO and EDEN	Multiple: Singapore & France	5-6	Questionnaire
Chomitz et al. (2018)	Healthy Living Behaviors Among Chinese-American Preschool-Aged Children: Results of a Parent Survey	United States	3-6	Questionnaire
Chung et al. (2021)	The association of BMI and physical activity on acetabular dysplasia in children	Netherlands	9	Questionnaire
Cleland et al. (2008)	A prospective examination of children'™s time spent outdoors, objectively measured physical activity and overweight	Australia	5-12	Questionnaire
Contreras et al. (2020)	Rural-urban differences in body mass index and obesity-related behaviors among low-income preschoolers	United States	3-4	Questionnaire
Cortinez-O'Ryan et al. (2017)	Reclaiming streets for outdoor play: A process and impact evaluation of "Juega en tu Barrio" (Play in your Neighborhood), an intervention to increase physical activity and opportunities for play	United States	4-12	Questionnaire
Dealey & Stone (2018)	Exploring out-of-school play and educational readiness	United States	5	Questionnaire
Deforche et al. (2009)	Objectively measured physical activity, physical activity related personality and body mass index in 6- to 10-yr-old children: A cross-sectional study	Belgium	6-10	Questionnaire
Delisle Nyström et al. (2019)	Relationships between area-level socioeconomic status and urbanization with active transportation, independent mobility, outdoor time, and physical activity among Canadian children.	Canada	8-13	Questionnaire
de Macêdo et al. (2022)	Urban Mobility and Subjective Well-Being among Brazilian Children	Brazil	9-14	Questionnaire
Dodd et al. (2021a)	Children's play and independent mobility in 2020: Results from the British children's play survey	Britain	5-11	Questionnaire
Dodd et al. (2021b)	Development and evaluation of a new measure of children's play: the Children's Play Scale (CPS)	United Kingdom	5-11	Questionnaire
Dodd et al. (2022)	Child's Play: Examining the Association Between Time Spent Playing and Child Mental Health	England	5-11	Questionnaire
D'Souza et al. (2021)	A comparison of children's diet and movement behaviour patterns derived from three unsupervised multivariate methods	Australia	3-8	Questionnaire
Egan et al. (2021)	The home play environment: The Play and Learning in the Early Years (PLEY) Study	Ireland	0-5	Questionnaire
Essery et al. (2008)	Mothers of Preschoolers Report Using Less Pressure in Child Feeding Situations Following a Newsletter Intervention	United States	2-5	Questionnaires
Eurenius et al. (2021)	Social-Emotional Problems Among 3-Year-Olds Are Associated With an Unhealthy Lifestyle: A Population-Based Study	Sweden	3	Questionnaire
Ferrao & Janssen (2015)	Parental encouragement is positively associated with outdoor active play outside of school hours among 7-12 year olds	United States	7-12	Questionnaire

Ferrao. (2015)	How parents influence outdoor active play among 7-12 year old children	United States	7-12	Questionnaire
Ford et al. (2002)	Primary care interventions to reduce television viewing in African-American children	Georgia	7-12	Questionnaire
Gerards et al. (2015)	The effectiveness of lifestyle triple P in the Netherlands: A randomized controlled trial	Netherlands	4-8	Questionnaire
Goodman et al. (2011)	Activity compensation and activity synergy in British 8-13 year olds	England	8-13	Diary
Goodman et al. (2012)	Day length and weather effects on children's physical activity and participation in play, sports, and active travel	England	8-11	Diary
Grammatikopoulou et al. (2018)	Edmonton obesity staging system among pediatric patients: a validation and obesogenic risk factor analysis	Greece	2-14	Questionnaire
Grigsby-Toussaint et al. (2011)	Where they live, how they play: neighborhood greenness and outdoor physical activity among preschoolers	United States	2-5	Questionnaire
Gross et al. (2013)	Maternal depressive symptoms and child obesity in low-income urban families	United States	5	Questionnaire
Hallit et al. (2021a)	Prevalence of asthma, its correlates, and validation of the Pre-School Asthma Risk Factors Scale (PS-ARFS) among preschool children in Lebanon	Lebanon	3-5	Questionnaire
Hallit et al. (2021b)	The Preschool Asthma Risk Factors Scale: A Predictive Tool For Asthma And Respiratory Symptoms Among Preschool Children In Lebanon	Lebanon	3-5	Questionnaire
Hammond et al. (2011)	Growing Minds: The Relationship Between Parental Attitudes Toward Their Child's Outdoor Recreation and Their Child's Health	United States	6-13	Questionnaire
Handal et al. (2007)	Neurobehavioral development in children with potential exposure to pesticides	Ecuador	2-5	Questionnaire
Hawlader et al. (2019)	Determinants of vitamin D deficiency among Bangladeshi children: A hospital based case-control study	Bangladesh	1-13	Interview
Heinen et al. (2016)	The Childhood Obesity Surveillance Initiative (COSI) in the Republic of Ireland: Descriptives of childhood obesity risk factors	Ireland	5-12	Questionnaire
Hinkley et al. (2018)	Cross sectional associations of screen time and outdoor play with social skills in preschool children	Australia	2-5	Questionnaire
Hofferth & Sandberg (2001)	Changes in American Children's Time, 1981-1997	United States	3-17	Diary
Holmes et al. (2022)	Making connections between learning centres and children's play lives during the covid-19 pandemic	United States	1-5	Diary
Hunter et al. (2020)	Moderators of parents' perceptions of the neighborhood environment and children's physical activity, time outside, and screen time	Australia	3-17	Questionnaire
Hurwitz et al. (2020)	Only So Many Hours in a Day: Early Childhood Screen Time in Boston and Mexico City	Multiple: United States & Mexico	2-8	Diary
Husmann et al. (2017)	Low 25(OH)-vitamin D concentrations are associated with emotional and behavioral problems in German children and adolescents	Germany	3-17	Questionnaire
Imhof et al. (2015)	The association of socio-economic factors with physical fitness and activity behaviours, spinal posture and retinal vessel parameters in first graders in	Switzerland	7-8	Questionnaire

	urban Switzerland			
Ishihama et al. (2020)	What Japanese Children Actually Do and What They Wish To Do in Their Free Time	Japan	8-12	Questionnaire
Itoi et al. (2015)	Decline in objective physical activity over a 10-year period in a Japanese elementary school	Japan	11-12	Diary
Jansen et al. (2010)	Weight status, energy-balance behaviours and intentions in 9-12-year-old inner-city children.	Netherlands	9-12	Questionnaire
Janssen I. (2015)	Hyper-parenting is negatively associated with physical activity among 7-12 year olds	Multiple: Canada & United States	7-12	Questionnaire
Janssen I. (2016)	Estimating Whether Replacing Time in Active Outdoor Play and Sedentary Video Games With Active Video Games Influences Youth's Mental Health	Canada	11-15	Questionnaire
Katz & Lambert (2011)	A new look at myopia development: Possible links with childhood stress and diet	United States	6-13	Questionnaire
Kim et al. (2018)	How does low socioeconomic status increase blood lead levels in Korean children?	South Korea	7-12	Questionnaire
Kobel et al. (2015)	Correlates of habitual physical activity and organized sports in German primary school children	Germany	6-9	Questionnaire
Kocken et al. (2012)	Ethnic differences and parental beliefs are important for overweight prevention and management in children: a cross-sectional study in the Netherlands	Netherlands	6-12	Questionnaire
Koning et al. (2018)	Agreement between parent and child report of physical activity, sedentary and dietary behaviours in 9-12-year-old children and associations with children's weight status	Netherlands	9-12	Questionnaire
Kovacs et al. (2021)	Physical activity, screen time and the COVID-19 school closures in Europe - an observational study in 10 countries	Multiple: the Russian Federation, Spain, Italy, Germany, France,Belgium (Flemish Region), Portu-gal, Romania, Hungary, Poland and Slovenia	6-18	Questionnaire
Krause et al. (2015)	Ascaris and hookworm transmission in preschool children from rural Panama: Role of yard environment, soil eggs/larvae and hygiene and play behaviours	Panama	0-5	Questionnaire
Larson et al. (2011)	Children's Time Outdoors: Results and Implications of the National Kids Survey	United States	6-19	Questionnaire
Lehrer et al. (2014)	Grade 1 students out-of-school play and its relationship to school-based academic, behavior, and creativity outcomes	Canada	6-7	Diary
Liu (2014)	Behavioral, policy, and environmental approaches to obesity prevention in preschool-aged children	United States	3-4	Questionnaire

Loebach et al. (2021)	Paving the way for outdoor play: Examining socio-environmental barriers to community-based outdoor play	Canada	10-13	Questionnaire
Loucaides (2009)	School location and gender differences in personal, social, and environmental correlates of physical activity in Cypriot middle school children	Cyprus	12-15	Questionnaire
Loucaides et al. (2004)	Correlates of Physical Activity in a Cypriot Sample of Sixth-Grade Children	Cyprus	11-12	Questionnaire
Loucaides & Jago (2006)	Correlates of Pedometer-Assessed Physical Activity in Cypriot Elementary School Children.	Cyprus	10-12	Questionnaire
Loucaides & Tsangaridou (2017)	Associations between Parental and Friend Social Support and Children's Physical Activity and Time Spent outside Playing.	Cyprus	11-12	Diary
Lu et al. (2019)	Environmental correlates of sedentary time and physical activity in preschool children living in a relatively rural setting in the netherlands: A cross-sectional analysis of the gecko drenthe cohort	Netherlands	3	Questionnaire
Lumeng et al. (2017)	Improving self-regulation for obesity prevention in head start: A randomized controlled trial	United States	0-5	Questionnaire
MacArthur (2012)	Active Videogaming Compared to Unstructured, Outdoor Play in Young Children: Percent Time in Moderate- to Vigorous-Intensity Physical Activity and Estimated Energy Expenditure.	United States	5-8	Questionnaire
Maher et al. (2022)	A cross-sectional study on the use of near-visual display devices in the Middle-Eastern children population	United Arab Emirates	4-16	Questionnaire
Marino et al. (2012)	Amount and environmental predictors of outdoor playtime at home and school: A cross-sectional analysis of a national sample of preschool-aged children attending Head Start	United States	3-4	Questionnaire
Marques et al. (2013)	Modifiable lifestyle behavior patterns, sedentary time and physical activity contexts: A cluster analysis among middle school boys and girls in the SALTA study	Portugal	11-12	Questionnaire
Marques et al. (2014)	Correlates of urban children's leisure-time physical activity and sedentary behaviors during school days	Portugal	10-12	Questionnaire
McDonald et al. (2009)	Overweight is more prevalent than stunting and is associated with socioeconomic status, maternal obesity, and a snacking dietary pattern in school children from Bogota, Colombia	Colombia	5-12	Questionnaire
McFarland et al. (2014)	The relationship between parental attitudes toward nature and the amount of time children spend in outdoor recreation	United States	3-5	Questionnaire
Molu et al. (2021)	Sleep problems, sleep environment and daily routines in Turkish preschoolers	Turkey	3-6	Questionnaire
Murgueytio et al. (1998)	Behaviors and blood lead levels of children in a lead-mining area and a comparison community	United States	0-7	Questionnaire
Myers et al. (2015)	Early childhood nutrition, active outdoor play and sources of information for families living in highly socially disadvantaged locations	Australia	0-4	Questionnaire
Mygind et al. (2020)	Is vegetation cover in key behaviour settings important for early childhood socioemotional function? A preregistered, cross-sectional study	Australia	2-5	Questionnaire

Nathan et al. (2021)	Impact of covid-19 restrictions on western Australian children's physical activity and screen time	Australia	5-9	Questionnaire
Nigg et al. (2021)	Relating outdoor play to sedentary behavior and physical activity in youth - results from a cohort study	Germany	6-17	Questionnaire
Nigg et al. (2022)	Urban-rural differences in children's and adolescent's physical activity and screen-time trends across 15 years	Germany	4-17	Questionnaire
Nordbakke (2019)	Children's out-of-home leisure activities: changes during the last decade in Norway	Norway	6-12	Questionnaire
Nriagu et al. (1997)	Lead poisoning of children in Africa III. Kaduna, Nigeria	Nigeria	1-6	Questionnaire
Nriagu et al. (2007)	Lead poisoning associated with malaria in children of urban areas of Nigeria	Nigeria	2-9	Questionnaire
Oakley et al. (2021)	Backyard benefits? A cross-sectional study of yard size and greenness and children's physical activity and outdoor play	Australia	6	Questionnaire
O'Conner et al. (2016)	Let's Get Real: are Today's Children Playing with Nature? do the Educational Aspirations of the Nature Play Movement Emerge within Children's Neighbourhood Play?	Ireland	0-14	Questionnaire
Oladosu et al. (2021)	Predictive value of serum Vitamin D3 level for forearm fractures among children in a tropical country: A case control study	Nigeria	0-15	Questionnaire
Page et al. (2010)	Independent mobility, perceptions of the built environment and children's participation in play, active travel and structured exercise and sport: The PEACH Project	United Kingdom	10-11	Questionnaire
Parent et al. (2021)	Social determinants of playing outdoors in the neighbourhood: family characteristics, trust in neighbours and daily outdoor play in early childhood	Canada	5	Questionnaire
Park et al. (2016)	Risk Factors for Functional Constipation in Young Children Attending Daycare Centers	South Korea	3-7	Questionnaire
Parker et al. (2016)	Physical Activity and Anthropometric Characteristics Among Urban Youth in Mexico: A Cross-Sectional Study	Mexico	8-11	Questionnaire
Pelc et al. (2016)	Environmental and socioeconomic factors contributing to elevated blood lead levels in children from an industrial area of Upper Silesia	Poland	3-18	Questionnaire
Pernica et al. (2012)	Risk factors predisposing to pedestrian road traffic injury in children living in Lima, Peru: A case-control study	Peru	2-17	Questionnaire
Pesce et al. (2016)	Deliberate Play and Preparation Jointly Benefit Motor and Cognitive Development: Mediated and Moderated Effects.	Italy	5-10	Questionnaire
Piccininni et al. (2018)	Outdoor play and nature connectedness as potential correlates of internalized mental health symptoms among Canadian adolescents	Canada	11-15	Questionnaire
Pineros-Leano (2018)	Association between early maternal depression and child growth: A group-based trajectory modeling analysis	United States	0-9	Questionnaire
Posner et al. (2002)	Exposure to traffic among urban children injured as pedestrians	unknown	4-15	Questionnaire
Poulain et al. (2020)	Loss of childcare and classroom teaching during the Covid-19-related lockdown in spring 2020: A longitudinal study on consequences on leisure	Germany	1-10	Questionnaire

	behavior and schoolwork at home			
Prioreschi & Norris (2020)	Describing correlates of early childhood screen time and outdoor time in Soweto, South Africa	South Africa	0-17	Questionnaire
Pullenayegum et al. (2021)	Clustered longitudinal data subject to irregular observation	Canada	0-5	Questionnaire
Qiu & Zhu (2021)	Housing and community environments vs. Independent mobility: Roles in promoting children's independent travel and unsupervised outdoor play	United States	7-11	Questionnaire
Rajabi et al. (2021)	Children's indoor and outdoor play as potential correlates of mental health during the COVID-19 pandemic in Iran: A brief report on national survey	Iran	5-11	Questionnaire
Reimers et al. (2019a)	Are there disparities in different domains of physical activity between school-aged migrant and non-migrant children and adolescents? Insights from Germany	Germany	6-17	Questionnaire
Reimers et al. (2019b)	Parental and peer support and modelling in relation to domain-specific physical activity participation in boys and girls from Germany	Germany	6-17	Questionnaire
Reimers et al. (2019c)	Social support and modelling in relation to physical activity participation and outdoor play in preschool children.	Germany	4-6	Questionnaire
Remmers et al. (2014a)	A longitudinal study of children's outside play using family environment and perceived physical environment as predictors	Netherlands	7	Questionnaire
Remmers et al. (2014b)	Correlates of parental misperception of their child's weight status: The 'be active, eat right' study	Netherlands	5	Questionnaire
Remmers et al. (2014c)	Moderators of the longitudinal relationship between the perceived physical environment and outside play in children: The KOALA birth cohort study	Netherlands	5-7	Questionnaire
Rodriguez-Ayllon et al. (2020)	Associations of physical activity and screen time with white matter microstructure in children from the general population.	Netherlands	10	Questionnaire
Ross et al. (2020)	The indirect influence of child play on the association between parent perceptions of the neighborhood environment and sense of community	United States	6-17	Questionnaire
Ruedl et al. (2022)	Association of modifiable factors with the development of physical fitness of Austrian primary school children: A 4-year longitudinal study	Austria	7-10	Questionnaire
Ryan et al. (2012)	Bone mineral density and vitamin D status among African American children with forearm fractures	United States	5-9	Questionnaire
Sääkslahtet al. (1999)	Is physical activity related to body size, fundamental motor skills, and CHD risk factors in early childhood?	Finland	3-4	Diary
Sääkslahti et al. (2004)	Physical activity as a preventive measure for coronary heart disease risk factors in early childhood	Finland	4-5	Diary
Saldanha-Gomes et al. (2017)	Prospective associations between energy balance-related behaviors at 2 years of age and subsequent adiposity: The EDEN mother-child cohort	France	5	Questionnaire
Saldanha-Gomes et al. (2020)	Clusters of diet, physical activity, television exposure and sleep habits and their association with adiposity in preschool children: The EDEN mother-child cohort	France	2-5	Questionnaire
Saldanha-Gomes et al.	Prospective associations between dietary patterns, screen and outdoor play	France	2	Questionnaire

(2022)	times at 2 years and age at adiposity rebound: The EDEN mother-child cohort			
Sarker et al. (2015)	Validation of parent-reported physical activity and sedentary time by accelerometry in young children	Canada	0-5	Questionnaire
Schmidt et al. (2017)	Physical activity of German children and adolescents 2003-2012: The MoMo-study	Germany	4-17	Questionnaire
Schmidt et al. (2019)	Development of atopic sensitization in Finnish and Estonian children: A latent class analysis in a multicenter cohort	Multiple: Estonia & Finland	3	Questionnaire
Schmidt et al. (2020)	The physical activity of children and adolescents in Germany 2003-2017: The MoMo-study	Germany	4-17	Questionnaire
Schmidt et al. (2022)	Influence of socioeconomic variables on physical activity and screen time of children and adolescents during the COVID-19 lockdown in Germany: the MoMo study	Germany	4-17	Questionnaire
Schoeppe et al. (2014)	Associations between children's independent mobility and physical activity	Australia	8-13	Questionnaire
Schwarzfischer et al. (2020)	Effects of screen time and playing outside on anthropometric measures in preschool aged children	Multiple: Italy, Germany, Poland, Spain & Belgium	3-6	Questionnaire
Seham & Schey (1934)	The influence of the environment upon health and function	Unknown	8-15	Questionnaire
Sharp et al. (2014)	Temperament is associated with free play in young children	Canada	1-5	Questionnaire
Sharp et al. (2017)	Temperament ıs associated with outdoor free play in young children: A TARGet Kids! Study.	Canada	1-5	Questionnaire
Shinomiya et al. (2021)	Sleep and the general behavior of ınfants and parents during the closure of schools as a result of the COVID-19 Pandemic: Comparison with 2019 data	Japan	2	Questionnaire
Sijtsma et al. (2015)	Television, sleep, outdoor play and BMI in young children: the GECKO Drenthe cohort.	Netherlands	3-4	Questionnaire
Silva & Santos (2017)	Playing outdoor and practising sport: A study of physical activity levels in Portuguese children	Portugal	11-12	Questionnaire
Sioen et al. (2011)	Determinants of vitamin D status in young children: results from the Belgian arm of the IDEFICS (Identification and Prevention of Dietary- and Lifestyle-Induced Health Effects in Children and Infants) Study	Belgium	4-11	Questionnaire
Slutsky & DeShetler (2017)	How technology is transforming the ways in which children play	United States	3-5yr	Diary
Sterman et al. (2019)	Mothers supporting play as a choice for children with disabilities within a culturally and linguistically diverse community	Australia	5-12	Diary
Stone & Faulkner (2014)	Outdoor play in children: Associations with objectively-measured physical activity, sedentary behavior and weight status	Canada	10-12	Questionnaire
Stracciolini et al. (2021)	Attitudes and behaviors of physical activity in children: Findings from the Play, Lifestyle & Activity in Youth (PLAY) Questionnaire	United States	6-11	Questionnaire
Sum et al. (2022)	COVID-19-Related Life Experiences, Outdoor Play, and Long-term Adiposity Changes among Preschool-and School-Aged Children in Singapore 1 Year	Singapore	1-10	Questionnaire

	after Lockdown			
Surdu et al. (2006)	Blood lead levels and hand lead contamination in children ages 4-6 in Copsa Mica, Romania	Romania	4-6	Questionnaire
Syahrul et al. (2016)	Prevalence of underweight and overweight among school-aged children and it's association with children's sociodemographic and lifestyle in Indonesia	Indonesia	6-13	Questionnaire
Tabatabaei et al. (2022	Biomonitoring of BTEX in primary school children exposed to hookah smoke	Iran	7-13	Questionnaire
Takahashi et al. (1999)	Influence factors on the development of obesity in 3-year-old children based on the Toyama study	Japan	3	Questionnaire
Tang & Woolley (2021)	No time for play: Children's daily activities during summer holidays in the Beijing central area	China	6-12	Diary
Thakor et al. (2004)	Effect of Physical and Mental Activity on Blood Pressure	India	10-15	Questionnaire
Thompson et al. (2005)	Factors Influencing the Physically Active Leisure of Children and Youth: A Qualitative Study	Canada	8-10	Questionnaire
Tolbert et al. (2011)	Young children in urban areas: Links among neighborhood characteristics, weight status, outdoor play, and television watching	United States	5	Questionnaire
van Grieken et al. (2014)	Promotion of a healthy lifestyle among 5-year-old overweight children: health behavior outcomes of the 'Be active, eat right' study	Netherlands	5	Questionnaire
van Grieken et al. (2017)	Personalized Web-Based Advice in Combination With Well-Child Visits to Prevent Overweight in Young Children: Cluster Randomized Controlled Trial	Netherlands	3	Questionnaire
van Rossema et al. (2012)	An observational study on socio-economic and ethnic differences in indicators of sedentary behavior and physical activity in preschool children	Netherlands	3	Questionnaire
van Stralen et al. (2012)	Mediators of the effect of the JUMP-in intervention on physical activity and sedentary behavior in Dutch primary schoolchildren from disadvantaged neighborhoods	Netherlands	8-12	Questionnaire
Veitch et al. (2009)	The validity and reliability of an instrument to assess children's outdoor play in various locations	Australia	8-12	Questionnaire; Diary
Veldhuis et al. (2012)	Behavioral risk factors for overweight in early childhood; the 'Be active, eat right' study	Netherlands	5	Questionnaire
Vera-Becerra et al. (2015)	Child Feeding Practices and Overweight Status Among Mexican Immigrant Families	Multiple: United States & Mexico	1-6	Questionnaire
Verbestel et al. (2014)	Are context-specific measures of parental-reported physical activity and sedentary behaviour associated with accelerometer data in 2-9-year-old European children?	Multiple: Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain and Sweden	2-9	Questionnaire
Verburgh et al. (2016)	Do elite and amateur soccer players outperform non-athletes on neurocognitive functioning? A study among 8-12 year old children	Netherlands	8-12	Questionnaire
Wada et al. (2012)	Associations of birth weight and physical activity with sex steroids in preschool Japanese children.	Japan	3-6	Questionnaire

Wang et al. (2020)	The associations between outdoor playtime, screen-viewing time, and environmental factors in chinese young children: The "eat, be active and sleep well" study	China	3-6	Questionnaire
Wang et al. (2021)	Associations among Outdoor Playtime, Screen Time, and Environmental Factors in Japanese Preschoolers: The 'Eat, Be Active, and Sleep Well' Study	Japan	3-5	Questionnaire
Watanabe et al. (2006)	Association of parental and children behaviors with the health status of preschool children	Japan	3-5	Questionnaire
Watanabe et al. (2016)	Clustering patterns of obesity-related multiple lifestyle behaviours and their associations with overweight and family environments: A cross-sectional study in Japanese preschool children	Japan	3-6	Questionnaire
Watowicz et al. (2012)	Lifestyle behaviors of obese children following parental weight loss surgery	United States	9-16	Questionnaire
Wen et al. (2009)	Time spent playing outdoors after school and its relationship with independent mobility: A cross-sectional survey of children aged 10-12 years in Sydney, Australia	Australia	10-12	Diary
Wijga et al (2010)	Diet, Screen Time, Physical Activity, and Childhood Overweight in the General Population and in High Risk Subgroups: Prospective Analyses in the PIAMA Birth Cohort.	Netherlands	5-7	Questionnaire
Wijnhoven et al. (2015)	WHO European Childhood Obesity Surveillance Initiative: health-risk behaviours on nutrition and physical activity in 6-9-year-old schoolchildren	Multiple: Bulgaria, Czech Republic, Lithuania, Portugal & Sweden	6-9	Questionnaire
Wijtzes et al. (2014a)	Sedentary behaviors, physical activity behaviors, and body fat in 6-year-old children: The Generation R Study	Netherlands	6	Questionnaire
Wijtzes et al. (2014b)	Social inequalities in young children's sports participation and outdoor play	Netherlands	6	Questionnaire
Worobey et al. (2013)	Child outdoor physical activity is reduced by prevalence of the Asian Tiger Mosquito, Aedes albopictus	United States	8-12	Diary
Wosje et al. (2010)	Dietary patterns associated with fat and bone mass in young children	United States	3-7	Questionnaire
Xu et al. (2014a)	Associations of maternal influences with outdoor play and screen time of two-year-olds: Findings from the Healthy Beginnings Trial	Australia	2	Questionnaire
Xu et al. (2016b)	Associations of outdoor play and screen time with nocturnal sleep duration and pattern among young children	Australia	2-5	Questionnaire
Xu et al. (2016)	A 5-year longitudinal analysis of modifiable predictors for outdoor play and screen-time of 2- to 5-year-olds	Australia	2-5	Questionnaire
Xu et al. (2017)	Mothers' perceived neighbourhood environment and outdoor play of 2- to 3.5-year-old children: Findings from the healthy beginnings trial	Australia	2-3.5	Questionnaire
Yoon & Lee (2019)	Neighborhood outdoor play of White and Non-White Hispanic children: Cultural differences and environmental disparities	United States	5-11	Questionnaire

Appendix 3. A Typology of Measurement Approaches for Outdoor Free Play

Focus of measure (occurrence / frequency / duration)[1]	**Question Framing (actual / typical / average)[2]**	**Reference time period[3]**	**Question features/examples**	**Response formats**	**No. of data entry points**	**Age (yrs)**	**Articles (common instruments in bold)[4]**
Respondent: Child/youth							
Logbook							
Duration of OFP	Actual OFP	A day during school summer holiday	What activities did you do? Who accompanied you?	Open text for each hour.	One day.	6-12	Tang & Woolley (2021).
Frequency and duration of OFP	Actual OFP	A day	What activities did you do and how long did you engage in them for?	Marked in a minute-by-minute chart. Pre-set options.	Daily for five days.	8-12	Itoi et al. (2015), Worobey et al. (2013).
			Where were you and what did you do there?	Open text.	Daily for 4 days.	8-13	Goodman et al. (2011)[5], Goodman et al. (2012)[5].
			How long did you spend playing outdoors after school yesterday?	Ordinal scale ('none' to 4+ hours).	Daily for 5-6 days.	10-12	Loucaides & Tsangaridou (2017), Wen et al. (2009).
Questionnaire							
Occurrence of OFP	Actual OFP	Previous week	'I spent time outside'	Ordinal scale ('strongly disagree' to 'strongly agree')	One.	10-12	Andrejewski (2011).
	Typical OFP	n/a	'Things I do after school: • play outside with my friends • play outside on my own • play unorganized sports.'	Yes/No	One.	8-10	Thompson et al. (2005).
Frequency of OFP	Typical OFP	n/a	How often do you normally play out?	Ordinal scale ('never' or 'almost never' to 'daily' or 'nearly every day').	One	10-12	**Motorik-Modul Physical Activity Questionnaire (MoMo-PAQ):** Schmidt et al. (2020)[6]. Marques et al. (2013), Marques et al. (2014), Page et al. (2010), Silva & Santos (2017).

		When aged 6-13yrs	How often they played outdoors.	Ordinal scale ('not sure' to 'often').	One	n/a	Katz & Lambert (2011)[7].
		A week	How often do you play outside? How often do you play outdoors in your neighbourhood, and is this usually with or without an adult present?	Interval scale (number of days). Ordinal scale ('never' to '5+ times a week' or 'daily').	One. Two (summer and winter).	8-17	**MoMo-PAQ:** Reimers et al. (2019b)[6]. de Macêdo et al. (2022), Prezza et al. (2010), Schoeppe et al. (2014), van Stralen et al. (2012),
Duration of OFP	Actual OFP	Previous day	How long did you play outdoors after school?	Ordinal scale (<30mins to 3+hrs).	One.	8-12	Ishihama et al. (2020), Jansen et al. (2010).
	Typical OFP	A day	In your free time, how many hours do you spend playing outdoors outside of school hours?	Ordinal scale ('none' to 7+hrs).	One. Two (a weekday and a weekend day).	8-15	Janssen I. (2016), Loucaides (2009), Piccininni et al. (2018), Seham & Schey (1934), Thakor et al. (2004).
		A day	What activities do you do and how long for?	Set list of activities with 'other' option. Times 'from/to'.	Two (school day and school holiday day).	7-15	Bhuyan & Zhang (2020)[8].
		Previous week	How much time did you spend outdoors on a weekday?	Ordinal scale ('none' to 4+hrs)	One.	16-19	Larson et al. (2011)[6].
	Average OFP	n/a	How many hours per day do you play outside?	Ordinal scale ('none' to 5+hrs)	One	6-11	Stracciolini et al. (2021).

Frequency and duration of OFP	Typical OFP	A week	How often do you play outdoors without adult supervision? How long do you spend playing out on those days?	Interval scale (0-7 days a week). Ordinal scale (<30min to 3+ hours). Free text (minutes).	One	8-17	**MoMo-PAQ:** Nigg et al. (2021)[6]; Nigg et al. (2022)[6]; Reimers et al. (2019a)[6]; Schmidt et al. (2017)[6], Schmidt et al. (2022)[6]. Loebach et al. (2021), Verburgh et al. (2016)
		A school week (Mon-Fri)	On how many days do you play outside after school? How much time do you spend playing outside?	Interval scale (0-5 days). Ordinal scale (none to 2+ hours)	One	9-12	Koning et al. (2018)[6].
Respondent: Parent/guardian and children together							
Logbook							
Duration of OFP	Actual OFP	A day	What was the child doing?	Open text and start/end times	Two (a weekday and a weekend day)	3-17	Hofferth & Sandberg (2001)
Interview							
Duration of OFP	Typical OFP	n/a	Does the child play outside and how long for?	Yes/No. Hours/minutes.	One	1-13	Hawlader et al. (2019)
Questionnaire[9]							
Frequency of OFP	Actual OFP	n/a	Does the child play outside every day?	Yes/No	One.	7-13	Tabatabaei et al. (2022)
	Typical OFP	n/a	How often do you play outside?	Ordinal scale (almost never to nearly every day)	One	4-11	**MoMo-PAQ:** Husmann et al. (2017), Schmidt et al. (2020)[6].
		A week	How often do you play outdoors after school without the presence of adults?	Interval scale (0-7 days). Ordinal scale (never to almost daily or daily)	One	3-12	**MoMo-PAQ:** Reimers et al. (2019b)[6]. Nordbakke (2019).
Duration of OFP	Typical OFP	n/a	How much time do you spend playing outside?	Minutes/hours	One. Two (a weekday and a weekend	4-15	Ford et al (2002), Posner et al. (2002)

					day)		
		A day in the previous month	How long does the child spend playing outdoors?	Hours/mins per day	Two (a weekday and a weekend day)	5-9	**Outdoor Time Recall instrument**: Ryan et al. (2012).
Frequency and duration of OFP	Typical OFP	n/a	How often do you play outside and how long for?	Undetermined	One	9-16	Watowicz et al. (2012)
		A week	How often do you play outside? How long on average during one of those days?	Interval scale (0-7 days). Free text (Minutes).	One	4-10	**MoMo-PAQ:** Reimers et al. (2019a)[6]; Reimers et al. (2019c); Nigg et al. (2021)[6]; Nigg et al. (2022)[6]; Schmidt et al. (2017)[6], Schmidt et al. (2022)[6].
Respondent: Parent/guardian							
Logbook							
Frequency of OFP	Actual OFP	A day	Did play occur for at least 10 minutes after school in specified outdoor locations.	Yes/no	Daily for 7 days.	8-12	Veitch et al., (2009)[5].
Duration of OFP	Actual OFP	A weekend	Select the activity the child was engaged was for every 5-minute interval.	Set options.	Daily for 4 days.	3-5	Sääkslahti et al. (1999), Sääkslahti et al. (2004).
		A day	Select the activity the child was engaged was for every 15-minute interval.	Set options.	Four (2 random weekdays and 2 random weekend days for 2 weeks)	2-8	Hurwitz et al. (2020).
		A typical day	The child's activities between the hours of 7:00 am and 9:00 pm in 15-minute increments	Open ended	Two (a weekday and a weekend day)	3-5	Slutsky & DeShetler (2017).
		A typical school day	The amount of time the child was engaged in different types of play, the location, and who the child was with.	Ordinal scale ('none' to 2+ hours)		6-7	Lehrer et al. (2014).
Frequency and duration of OFP	Actual OFP	A day	List and describe outdoor pay activities that took place and the context.	Open ended	Daily for 1-2 weeks	1-12	Holmes et al. (2022), Sterman et al. (2019).

Questionnaire [10]							
Occurrence of OFP	Actual OFP	n/a	Does your child ever play outside in public spaces without close supervision?	Yes/No/Unsure	One	6-13	Aggioa et al. (2017), Shinomiya et al. (2021)
Frequency of OFP	Actual OFP	n/a	Does your child play outdoors daily?	Yes/No	One	4-16	Maher et al. (2022)
		Previous week	How often did your child play outside? On which days did your child play outdoors for 30+ mins?	Ordinal scale ('daily' or 'at least once a day' to 'never'). Nominal items (days of the week).	One	1-15	Bhuyan & Zhang (2020)[8], Parker et al. (2016), Poulain et al. (2020)
	Typical OFP	n/a	How often does your child play outside?	Interval scale (number of days). Ordinal scale ('>3 times per week' to '1 time p/w'; 'more than once a day' to 'rarely/never,'; 'daily' to 'seldom').	One	1-17	Chomitz et al (2017), Ross et al. (2020), Schmidt et al. (2019), Sum et al. (2022), Wijga et al. (2010)
		A week	How often does the child play outside? The number of days the child spent playing in various specified locations for at least 10 minutes after school.	Interval scale (number of days). Ordinal scale ('never', 'rarely' or 'child plays mainly inside' to '5+ days per week' or 'every Saturday and Sunday').	One Two (Mon-Fri and Sat-Sun)	0-17	Balcerek et al (2017), Grammatikopoulou et al. (2018), Pesce et al. (2016), Ruedl et al. (2022), Veitch et al. (2009)[5]
		Previous month	How often did your child play outdoors in various specified locations?	Ordinal scale ('never' to 'daily').	One	7-12	Ferrao (2015), Ferrao & Janssen (2015), Janssen (2015)
	Average OFP	Previous six months	How often did your child play outside in the neighbourhood?	Ordinal scale ('never' to 'every day each week')	One	5	Parent et al. (2021)
Duration of OFP	Actual time in OFP	Most recent typical weekday	Did the child spend any time playing outside and, if so, the amount of time?	Yes/no and ordinal scale (<2 to 1+ hour).	One	3-4yr	**Head Start Family and Child Experiences Survey (FACES):** Liu (2014), Marino et al. (2012)
	Typical OFP	n/a	Aside from time in daycare/school, how much time does your child spend outside in	Minutes per day.	One. One (a	0-17	**Canadian Community Health Survey / TARGet Kids!**

			unstructured free play? How much time does your child spend playing outdoors? How much time does your child spend playing outdoors between waking up to noon, noon to 6pm and 6pm to bedtime.	Ordinal scale ('never' to 6+ hrs per day). Ordinal scale ('none' to 60+ mins per day)	weekday). Two (a weekday and a weekend day). Two (summer and winter). Three (school days, Sat-Sun, Wednesday [a non-school day]).		**Questionnaire:** Anderson et al. (2016), Carsley et al (2005), Pullenayegum et al. (2021), Sarker et al. (2015), Sharp et al. (2014), Sharp et al. (2017) **Childhood Obesity Surveillance Initiative (COSI) Family Form:** Bornhorst et al. (2015), Heinen et al. (2016), Wijnhoven et al. (2015). **EDEN birth mothers cohort:** Chia et al. (2022), Saldanha-Gomes et al. (2017), Saldanha-Gomes et al. (2020), Saldanha-Gomes et al. (2022). **Fragile Families and Child Wellbeing Study:** Burdette & Whitaker (2020), Pineros-Leano (2018), Tolbert et al. (2011). Adams & Prince (2010), Altun (2022), Berglind & Tynelius (2018), Caroli et al (2011), Deforche et al. (2009), D'Souza et al. (2021), Egan et al. (2021), Essery et al. (2008), Eurenius et al. (2021), Imhof et al. (2015), Kim et al. (2018), Kobel et al. (2015), Kovacs et al. (2021), Krause et al. (2015), Loucaides et al. (2004), Loucaides & Jago (2006), MacArthur (2012), Molu et al. (2021), Murgueytio et al. (1998), Myers et al. (2015), Nriagu et al. (1997), Nriagu et al. (2007) Park et al. (2016), Pelc et al. (2016), Prioreschi & Norris

							(2020), Sardu et al. (2006), Stone & Faulkner (2014), Syahrul et al. (2016), Takahashi et al. (1999), Vera-Becerra et al. (2015), Wada et al. (2012), Watanabe et al. (2006), Watanabe et al. (2016), Yoon & Lee (2019).
		A week	How much time does the child spend outdoors for play/recreation outside of school hours?	Hours/mins per day.	Two (Mon-Fri and Sat-Sun)	6	Oakley et al. (2021)
		A school week	How long does the child spend outside?	Total hours/mins.	Four (Mon-Fri and Sat-Sun for warmer cooler months)	6-12	Cleland et al. (2008).
		A day in the previous month	How long does the child spend playing outdoors?	Hours/mins per day.	Two (a weekday and a weekend day)	0-12	**Outdoor Time Recall instrument:** Buchanan et al. (2021), Burdette et al. (2004), Chesnut et al (2018), Contreras et al. (2020), Gross et al. (2013), Hinkley et al. (2018, Lumeng et al. (2017), Mygind et al. (2020), Nathan et al. (2021), Sioen et al. (2011), Verbestel et al. (2014), Wang et al. (2020), Wosje et al. (2010), Xu et al. (2014), Xu et al. (2016a), Xu et al. (2016b), Xu et al. (2017). Schwarzfischer et al. (2020).
		A day in the previous week	How much time did the young person spend outdoors?	Ordinal scale ('none' to '4+ hours' per day).	One (the week). Two (Mon-Fri and Sat-Sun)	3-17	Larson et al. (2011)[6], Hunter et al (2020).
		Currently	How much time does your child spend playing	Ordinal scale ('none'	Two	8-13	Delisle Nyström et al. (2019)

			outdoors?	to 3+ hrs per day).	(weekday and weekend day)		
	Average OFP	n/a	How long does the child play outdoors? How much time the child spent outdoors engaged in vigorous active play, moderately intensive play, and quiet play. How much time the child spent playing outside before noon, from noon until 6pm pm., and after 6pm	Hours/mins per day. Hours per week. Ordinal scale ('none' to 1+, 2+ or 4+ hrs per day).	One. Two (Mon-Fri and Sat-Sun).	2-17	Bringolf-Isler et al. (2010), Grigsby-Toussaint et al. (2011), Handal et al. (2007), Hammond et al. (2011), McDonald et al. (2009), McFarland et al. (2014), Qiu & Zhu (2021), Wang et al. (2021).
		Previous month	How much time the child been occupied with playing outside?	Ordinal scale ('none or less than 30 min/day' to 3+ hr/day).	Two (weekdays and weekend days)	3	**Generation R:** van Rossema et al. (2012).
Frequency and duration of OFP	Typical OFP	n/a	How often the child plays outdoors at specific locations while not in school, and the length of time the child spends playing at each. How many days per week and how many hours per day does the child play outdoors?	Ordinal scale ('never' to 'every day'). Ordinal scale (<30mins to 2+, 3+ or 4+ hrs per day).	Two (Autumn/ Winter and Spring/Summer). One (Mon-Fri). Two (Mon-Fri and Sat-Sun).	4-12	**Children's Play Scale:** Dodd et al. (2021a), Dodd et al. (2021b), Dodd et al. (2022), Rajabi et al. (2021). Cortinez-O'Ryan et al. (2017), Gerards et al. (2015), Kocken et al. (2012), Lu et al. (2019), Sijtsma et al. (2015).
		A week	How many days does the child play outside and how long for?	Ordinal scale ('once a week or less' to 'every day'). Hours/mins per occasion.	One.	3-6	Aktas Arnas & Saribas (2020).
		Previous month / four weeks	How many days does the child play outside and how long for?	Interval scale (number of days per week). Ordinal scale	One (a week). One (Mon-Fri).	4-12	Aarts et al. (2010), Aarts et al. (2012), Koning et al. (2018)[8], van Grieken et al. (2017).

				(<30mins to 2+ or 3+ hrs per day)	Two (Mon-Fri and Sat-Sun)		
	Average OFP	A week	How many days the child plays outside, and the duration of play in the morning, afternoon and evening.	Days per week. Minutes per day.	Two (Mon-Fri and Sat-Sun)	5-7	**Be Active, Eat Right Study:** Remmers et al. (2014a), Remmers et al. (2014b), van Grieken et al. (2014), Veldhuis et al. (2012)
		Current season	How many days the child plays outside and the duration of play in the morning, afternoon and evening.	Interval scale (days per week). Ordinal scale ('never' to 3-4hrs).	Two (Mon-Fri and Sat-Sun)	6-10	**Generation R:** Chungyz et al. (2021), Rodriguez-Ayllon et al. (2020), Wijtzes et al. (2014a), Wijtzes et al. (2014b).
		Previous four weeks	How many days the child played outside and the time spent in outside play	Interval scale (days per week). Ordinal scale (<30mins to 3+hrs per day).	One	5-7	Remmers et al. (2014c).

[1]Frequency and/or duration papers implicitly provide data on occurrence.
[2]Marked 'typical' if not explicitly stated.
[3]Marked 'n/a' if not explicitly stated.
[4]Instruments which were used and cited in three or more papers.
[5]More than one method to triangulate OFP.
[6]Different respondents for different child age ranges.
[7]Study conducted with undergraduate students.
[8]Separate measures for children and parents.
[9]Excludes Oladosu et al. (2021) as not enough information provided.
[10]Excludes Dealey & Stone (2018), Hallit et al. (2021a), Hallit et al. (2021b), O'Conner et al. (2016), Pernica et al. (2012) as not enough information provided.