

# **Youth Sport Trust: Early Years Physical Activity Review**

FINAL REPORT

AUGUST 2023

PREPARED BY

**DR JANINE COATES; LIZ PHAROAH; DR SILVIA COSTA & DR JULIE STIRRUP**

School of Sport, Exercise and Health Sciences, Loughborough University



**Loughborough  
University**

## Table of Contents

Executive Summary.....	3
1. Introduction .....	5
2. Methodology.....	6
2.1. Search Strategy .....	6
2.1.2. Search Databases and Terms.....	6
2.1.3. Inclusion / Exclusion Criteria .....	7
2.2. Screening, data extraction and analysis .....	8
3. Review Findings.....	9
3.1. Promoting physical development and fundamental movement skills.....	11
3.1.1. Physical activity, sedentary behaviour and fundamental movement skills .....	11
3.2. The influence of the childcare setting on physical activity .....	13
3.2.1. Physical activity in nurseries and preschools.....	13
3.2.2. Factors influencing physical activity at childminders / family childcare homes...	16
3.2.3. Factors influencing physical activity at home .....	17
3.3. The influence of the childcare provider on physical activity .....	18
3.3.1. The influence of childcare practitioners in nursery and preschool settings .....	18
3.3.2. The influence of childminders (FCCH practitioners) on children’s physical activity .....	19
3.3.4. The influence of parents on children’s physical activity .....	19
3.4. The impact of physical activity policies and guidelines .....	21
3.4.1. National / international physical activity guidelines.....	21
3.4.2. Local / regional physical activity policies .....	22
3.5. Physical activity in infants (up to 24 months).....	23
4. Conclusion.....	24
5. References .....	28

## Executive Summary

This review updates and extends the findings presented by McGeorge (2018) to the Youth Sport Trust, through a systematic review of literature relating to physical activity, physical development and physical literacy among children in the early years (aged 5 years and under). Through their review, McGeorge (2018) presented 7 promising principles to facilitate physical activity in children under 5 in early years settings like nurseries and preschools. These promising principles were:

1. Ensure practitioners receive appropriate training and support which improves their knowledge and understanding about physical activity and sedentary behaviour and increases their confidence to support physical activity.
2. Create an ethos and environment that supports physical activity, including a formal physical activity policy, the provision of play equipment and adequate play spaces, and providing frequent opportunities for outdoor play.
3. Include a balance of child initiated and adult led physical activities.
4. Provide structured physical activity which supports the development of fundamental movement skills.
5. Integrate physical activity into daily routines and use it to support other areas of learning and development.
6. Involve parents and carers, raising their knowledge and awareness of physical activity, sharing activity ideas with them and encouraging them to build on the physical activities introduced in settings.
7. Deliver multi-component interventions.

The literature reviewed in this report supports these promising principles in relation to facilitating physical activity in Early Childcare Education Centres (ECECs, i.e. nurseries and preschools). This review found that settings which have written physical activity policies and experiences / well-trained staff, as well as those which encourage active play, and in particular outdoor play, support physical activity in young children. The play environment is important, such that setting as with larger indoor and outdoor areas, including natural elements (e.g., trees) and portable play equipment, and those which offered a range of active opportunities through construction play, role play, music and dance facilitated increased physical activity. The findings indicated that boys were reported to be more active than girls in ECECs, and this should be given more consideration.

Moving beyond ECECs, the findings indicate a need to better understand physical activity in other settings like childminders and children's homes. Some limited evidence showed that children who attend childminders are less active than those attending ECECs. The main barrier to physical activity here was a lack of suitable indoor and outdoor space. Like ECECs,

availability of portable play equipment supported increased physical activity. Childminder training and education was highlighted as a key recommendation.

Somewhat limited evidence was available in relation to physical activity at home and with parents. This literature showed that children may be less active at home compared with other childcare settings. Facilitators to physical activity at home were related to reduced parental screentime, higher parental physical activity, and increased parental self-efficacy. Further, socioeconomic status seemed to be a predictor of parental perceptions around children's play and physical activity, both at home and in ECEC settings, but more research is needed in relation to this.

High quantity and poor quality screentime is a significant concern across all settings, including ECEC's, childminders and at home, and was found to be a main factor related to children not achieving the 24-Hour Movement Guidelines.

Finally, very limited evidence in relation to physical activity in infancy (children aged 2 years and under) was available. The available evidence suggested that more parental understanding about the importance of tummy time, and reducing the amount of screen time and time infants are restrained in pushchairs / baby seats is needed. Further research is needed to better understand physical activity for this age group.

This review identified 5 core gaps within the literature where more evidence is needed to better understand how to facilitate quality physical activity and support physical development in children aged 5 years and under. These are:

1. Differences between childcare settings, with a focus on understanding physical activity in childminder and home settings, within a UK context.
2. Effective training mechanisms to improve childcare provider knowledge and understanding surrounding physical activity and, importantly, fundamental movement skills (FMS).
3. Sex differences in relation to physical activity across different childcare settings.
4. Activities, curricula and policy guidelines to support the development of FMS and increase physical activity in young children, within a UK context.
5. Physical activity and development in infancy, specifically in relation to parental understanding and effective practice in childcare settings.

## 1. Introduction

In 2017, the Youth Sport Trust commissioned an evidence review (McGeorge, 2018) to examine physical activity and sedentary behaviour in young children aged 2-5 years. This review examined evidence from 39 studies and indicated that the evidence base focusing on physical activity among children in the early years (0-5 years of age) was limited when compared with the availability of evidence for school-aged children and adolescents. However, based on the available evidence seven 'promising principles' for promoting physical activity and reducing sedentary behaviour in early years settings were identified. These best practice recommendations for early years settings to promote and encourage physical activity for children under 5 years of age are as follows:

1. Ensure practitioners receive appropriate training and support which improves their knowledge and understanding about physical activity and sedentary behaviour and increases their confidence to support physical activity.
2. Create an ethos and environment that supports physical activity, whereby settings:
  - Have a written physical activity policy in place.
  - Promote positive staff behaviour including prompting children to be active, playing with children, encouraging and acknowledging children's physical activity.
  - Where possible, decrease playground density (the number of children per square metre).
  - Provide portable play equipment such as balls, hoops, tunnels.
  - Limit sedentary opportunities (e.g. reduce TV viewing) and modify the environment to support activity.
  - Provide appropriate space for physical activity that maximises the potential of the available area (both indoors and outdoors).
  - Provide more frequent periods of outdoor play.
3. Include a balance of child initiated and adult led physical activities.
4. Provide structured physical activity which supports the development of fundamental movement skills.
5. Integrate physical activity into daily routines and use it to support other areas of learning and development.
6. Involve parents and carers, raising their knowledge and awareness of physical activity, sharing activity ideas with them and encouraging them to build on the physical activities introduced in settings.
7. Deliver multi-component interventions (including a range of the areas outlined above).

These promising principles identified a range of key focal points for examining and promoting physical activity in the early years. However, since their development, research has progressed with more focus on motor competence, physical literacy and fundamental movement skills (Cairney et al, 2019). The development of various physical activity and movement guidelines for children in the early years (e.g. Tremblay, 2020) has also led to a shift in thinking about young children’s physical activity. In addition to this, the COVID-19 pandemic impacted upon the ways in which early years practitioners and families engage young children in physical activity (Battelly, 2021; Lafave et al, 2021).

Given this, the Youth Sport Trust commissioned Loughborough University in March 2023 to undertake a new review. The aim of this review is to bring the evidence up-to-date to inform future systems change in relation to how stakeholders approach issues relating to the promotion of physical activity for children aged 5 and under. In relation to this, the current review aims to examine literature related to physical literacy and physical development more broadly alongside physical activity, extending the age range from 2-5 years to 0-5 years, therefore expanding on the findings from the 2018 review.

## 2. Methodology

A comprehensive, systematic literature review was undertaken to address the aims of this work. The search strategy was informed by the methodology used by McGeorge (2018), given the intention of this work to update the evidence presented in the previous review. However, some adaptations were made which are detailed in the sections below to enhance the rigor of the review.

The research question informing the systematic review of literature presented here was:

*What are the barriers and facilitators to physical activity, physical literacy, physical development and active play for children in the early years (0-5years)?*

### 2.1. Search Strategy

The search strategy used for this review built on the strategy used by McGeorge (2018). Searches were carried out between March and June 2023, and all searches and screening of papers were undertaken, collated and organised using Covidence review software.

#### 2.1.2. Search Databases and Terms

Two databases were searched: Pubmed (using title, abstract and textword) and Web of Science (using title, abstract and author keyword). The search terms were:

1. Physical activity:

physical activity OR activit\* OR exercise OR physical education OR play OR leisure OR locomotor activities OR motor OR skill OR fitness

2. Sedentary behaviour:

sedentary OR screen-time OR screen\*OR sitting

3. Population:

early year\* OR pre-school\* OR child\* OR girl\* OR boy\* OR childhood OR early childhood OR young child OR young children OR toddler OR infant

4. Setting:

pre-school OR early years OR childcare OR day care OR nurser\*OR kindergarten

Other relevant peer-reviewed papers (n=3; Duncombe and Preedy, 2021, Preedy et al, 2022; Suzuki, 2020) and grey literature (n=3; Battelley, 2020; Battelley, 2021; Lovett, 2022) identified by an Early Years Stakeholder group which were not identified through the searches were also included in the review. Additional grey and peer-reviewed literature were only included if they met inclusion criteria.

### 2.1.3. Inclusion / Exclusion Criteria

Inclusion criteria for this systematic review were adapted from the previous review, with some adaptations. Only articles published after November 2017 were included, with the exception of papers relating to physical literacy and physical development. Given these search terms were not included in the 2018 review, papers identified through these search terms were included from inception to current date. In addition, studies involving children aged under 2 years of age were also included.

Full details of the inclusion and exclusion criteria applied in the searches are detailed in Figure 1 below.

*Figure 1: Inclusion and exclusion criteria*

#### **Inclusion criteria:**

Study published 2017\* onwards.

Study must be written in English and relate to early years children living in the United Kingdom, Australia, Canada, USA and Europe.

Study aims include reference to physical activity, physical development, physical literacy and / or active play.

The study population is children aged 5 and under, or those working with children ages 5 and under (including parents/caregivers) – for longitudinal studies, studies must have an assessment point <5 years.

Qualitative studies must examine perceptions / experiences / attitudes relating to physical activity / physical development / physical literacy / active play in early years settings (including at home).

\*(physical development and physical literacy from inception – present day

**Exclude:**

Studies published only as an abstract.

Systematic reviews (including meta-analyses and narrative reviews).

Feasibility studies which focus wholly on study design.

Opinion pieces, theoretical papers, letters.

## 2.2. Screening, data extraction and analysis

Relevant studies were identified via a systematic screening process, which included:

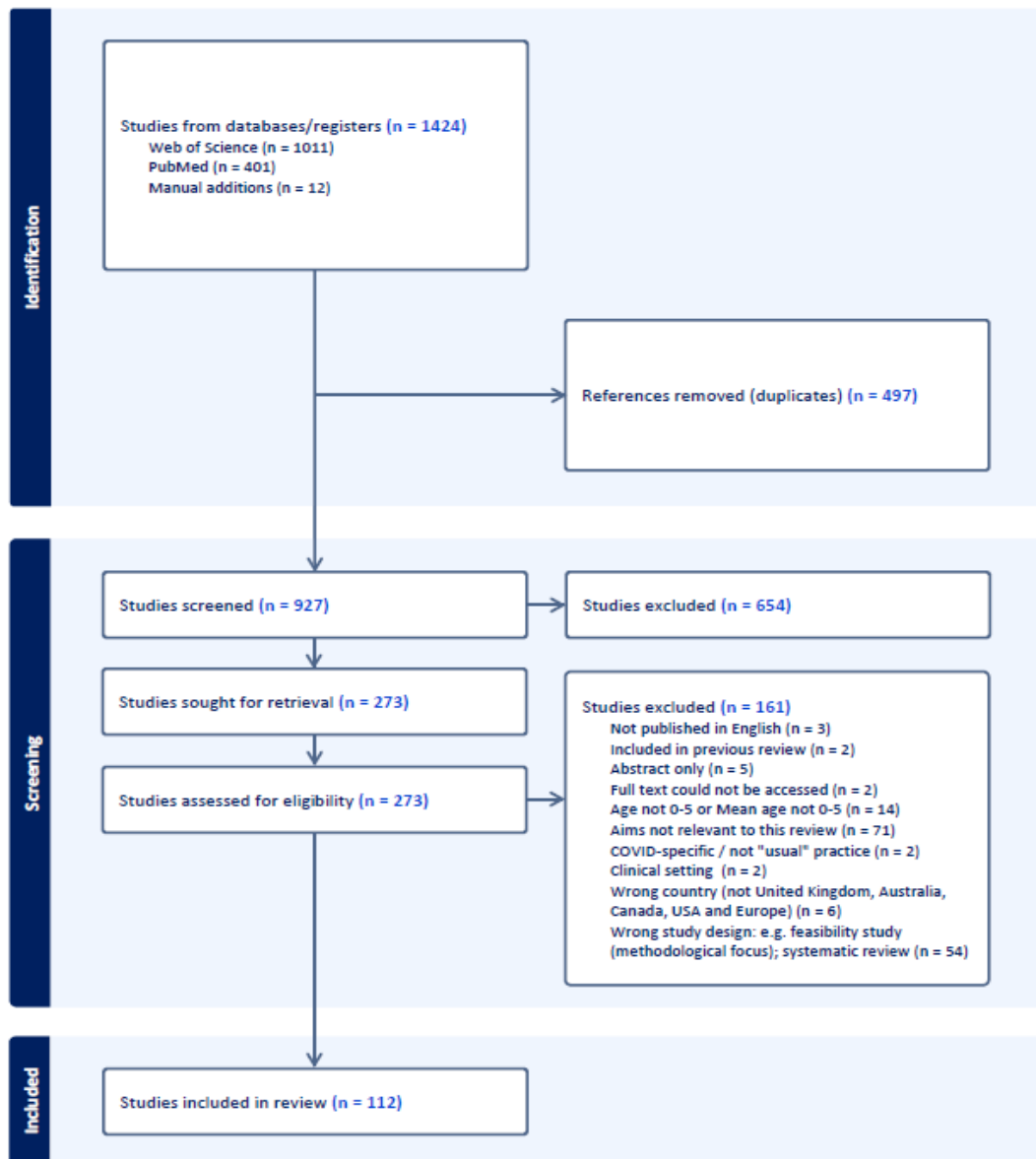
1. Removal of duplicate references
2. Screening titles of papers
3. Screening of abstracts
4. Full-text screening

Where papers met inclusion criteria at all stages of the screening process, relevant data was extracted, including full reference, study location, participant characteristics, methodological notes (i.e. methods used, key outcomes assessed) and key findings. These were collated via OneNote, and a summary of key findings was produced to inform the analysis. Figure 2 shows the implementation of this search strategy as a flow chart.

A thematic analysis of the extracted data was carried out to identify key themes in relation to the research question.



Figure 2: PRISMA Chart for the identification, screening, eligibility and inclusion of studies



### 3. Review Findings

A total of 112 papers were included in this review. 106 papers identified through the searches met inclusion criteria. The majority (n=65) of these studies were cross-sectional in design.

An additional 6 papers that were identified through the stakeholder group were added. These included 1 professional report (qualitative research), 1 postgraduate thesis (case study), 1 unpublished paper (mixed methods) and 3 additional peer reviewed papers not identified through the search (1 intervention study, 1 cross-sectional study, 1 experimental study).

Table 1 lists the study designs of the included papers:

*Table 1: Study designs of included papers*

<b>Study design</b>	<b>N</b>
Case study	2
Cross-section	66
Evaluation of randomised controlled trial	1
Experimental intervention	7
Longitudinal	7
Qualitative research	8
Mixed methods	1
Randomised controlled trial	20
Professional report	1
Unpublished report	1
<b>Total</b>	<b>112</b>

The majority (50%) of studies included in this review originated from North America (USA and Canada; n=55).

Table 2 details the geographical spread of the included studies.

*Table 1: Location of Included studies*

<b>Country</b>	<b>N</b>	<b>Country</b>	<b>N</b>
Australia	15	New Zealand	1
Austria	2	Norway	2
Belgium	2	Portugal	1
Canada	21	Spain	3
Finland	5	Sweden	3
Germany	2	Switzerland	2
Ireland	1	UK	13
Japan	1	USA	34
Netherlands	4		

### 3.1. Promoting physical development and fundamental movement skills

In this review, several studies argued that movement behaviours, e.g. targeted motor skill development, higher physical activity levels and reduced sedentary behaviour were important for physical development, specifically the development of fundamental movement skills (FMS). Preedy et al (2022) argue that physical development is an important facet of school readiness and is not sufficiently supported by the Early Years Foundation Stages framework. However, McConnell-Nzunga et al (2020) suggest there may be a lack of understanding of fundamental movement skills (or physical literacy) for staff in early years settings.

Research by Duncombe and Preedy (2021), show that in the 10 years between 2007 and 2017, the percentage of children starting school with or at risk of having a movement difficulty (32.17%) has almost doubled. There has also been a noted decline in motor skills which could be due to the increased use of screens and fewer outdoor play opportunities. Their study showed that teachers believe children are starting school less physically ready than in the past. They argue that “at the heart of this has to be a consideration of ways that we can get our youngest children to, not only move more, but to move in more developmentally appropriate ways” (Duncombe & Preedy, 2021:930).

A targeted intervention (Movement for Learning) for 4–5-year-old children evaluated by Preedy et al (2022) aimed to develop the movement skills of young children through a daily movement programme. The programme was designed to improve balance and fine/gross motor skill development whilst also inhibiting primitive reflexes. The research showed the programme improved both physical and academic skills. Preedy et al (2022) argue that successful intervention programmes targeting physical development are characterised by:

- taking a manageable time to complete (10–20 minutes per day);
- not requiring specialist equipment;
- requiring minimal training;
- delivery by practitioners.

#### 3.1.1. Physical activity, sedentary behaviour and fundamental movement skills

Studies have analysed the relationship between accelerometer-obtained movement behaviours for sleep, sedentary behaviour and physical activity, and healthy physical, cognitive and socioeconomic development (Bourke et al., 2022; Kuzik et al., 2020; Tsuda et al., 2020) however the findings are mixed. When physical activity intensity was examined, Kuzik et al (2020) found positive associations for moderate to vigorous physical activity (MVPA) and physical development, but associations were mixed for sedentary behaviour in relation to cognitive development. This could be due to some sedentary behaviours e.g., reading, impacting positively on cognitive development and others e.g., screen time, having detrimental effects (Kuzik et al., 2020). While Kuzik et al (2020) found no significant effect for light physical activity (LPA), Bourke et al (2022) found that replacing time spent participating

in sedentary behaviour or in MVPA with light physical activities led to greater physical functioning. They also note that there are benefits of sedentary time in relation to psychosocial functioning (Bourke et al., 2022). The mechanisms for these relationships between cognitive development and physical activity intensities are unknown and could be an area for future research (Kuzik et al., 2020). When creating guidelines for child development and health, more research is needed to identify the optimal composition of wake-time movement behaviour (Bourke et al., 2022).

In early years settings, developing greater FMS competence (object control and especially locomotor skills) alongside a positive perceived physical competence (children's perceptions about their own physical abilities) predicted increased engagement in MVPA and decreased sedentary behaviour during free play (Tsuda et al., 2020) and a greater amount of vigorous physical activity (Webster et al., 2019). As well as developing children's FMS, developing positive interactions with young children during instruction surrounding their physical competence is important (Tsuda et al., 2020).

Furthermore, encouraging more movement and at higher intensities allows for opportunities to practice FMS skill development (Webster et al., 2019), as the appropriate development of FMS in early years may encourage increased participation in a wider variety of physical activities through childhood (Gu, 2016). Hall et al (2018) showed that good motor competence is an important correlate of children meeting physical activity guidelines for health. Furthermore, longitudinal research by Miqueles et al (2023) showed that taking part in more vigorous physical activity at age 4 predicted improved body composition and fitness levels at age 9, suggesting the importance of FMS development and higher intensity physical activity in the early years.

Some research showed that solely participating in free play does not lead to children mastering FMS, however a mastery climate (including challenging activities relating to FMS and designed to encourage autonomy) led to increased time in MVPA and decreased sedentary behaviour (Wadsworth et al., 2017). Designing the physical environment to encourage FMS and physical activity rather than just focusing on physical activity alone, encouraged increased MVPA for all preschool children (Wadsworth et al., 2020). Within Wadsworth et al's (2020) study, a mastery motivational climate was assessed. This involved a lab-based intervention whereby children participated at activity stations which were designed to target locomotor skill development (i.e., running, jumping, hopping, sliding, leaping, and galloping) and object control skill (throwing, catching, bouncing, kicking, striking and rolling). The mastery environment was facilitated by the instructor allowing children to have full autonomy over the activities they participated in, as well as the length of time they spent at each station. Although this was a lab-based intervention, developing a mastery motivational climate during physical skill development activities in childcare settings could benefit children's FMS development. Specifically, improving the outdoor play environment and offering more outdoor play equipment can lead to higher process-based locomotor skills

(Szeszulski et al., 2022) alongside flexible, child-led engagement in activities which focus on locomotor skill development (Wadsworth et al., 2020).

Finally, while longitudinal research suggests that more than 90% of children do meet physical activity guidelines of 180 minutes or more per day, adherence to all movement guidelines (sleep, screentime and physical activity) was low (41% of 5 year olds met guidelines for all three) (Meredith-Jones et al., 2019). Screentime is a concern with regard to this. Researchers have considered the ways in which screen time is used in childcare environments. Szeszulski et al (2022) suggest the childcare environment is an important factor which influences quality movement skill development. Specifically, they state that a higher-quality outdoor play environment, more outdoor play equipment, and higher-quality screen-time environments are associated with higher process-based locomotor skills. While Staiano et al (2018) showed that timetabling screentime effectively into the curriculum so that it is only used for educational purposes can positively impact movement behaviours. The relationship between screen use and FMS may need further investigation.

### 3.2. The influence of the childcare setting on physical activity

Although most of the studies identified for inclusion in this review related to early years settings like nurseries and preschools (referred to as early childcare education centres; ECEC), recent literature has started to examine physical activity among young children in other settings including childminders (referred to as family childcare homes; FCCH), and home settings.

#### 3.2.1. Physical activity in nurseries and preschools

Research examining physical activity engagement in early years settings like nurseries and preschools was varied. Several studies suggested that engagement in physical activity whilst at early years settings was generally higher for older toddlers and boys, with higher amounts of total physical activity (TPA) and MVPA found among boys and older toddlers (Arhab et al, 2018; Machado-Rodrigues et al, 2021; Nilsen et al, 2019; Stone et al, 2019; Wadsworth et al, 2020; Woodfield et al, 2020; Vega-Perona et al., 2022). Nilsen et al (2019) suggest that currently nursery and preschool environments are organised so that boys, older children, and highly active children benefit more from this environment compared to girls, younger preschoolers, and children with lower MVPA levels. Environmental adaptations may be needed to encourage physical activity for a more children and targeted intervention for different groups of children may be needed. Machado-Rodrigues et al., (2021) showed that boys are significantly more active than girls and that lower levels of MVPA was associated with overweight in young children. They suggest that future interventions for improving weight should focus on increasing MVPA.

Research examining time spent active in settings was varied. Woodfield et al (2020), in a UK study of nursery and reception children, found that young children spend up to two-thirds of their time being stationary (65.8% for nursery and 69.8% for reception). This was supported by other studies internationally (Statler et al, 2020; Kyhälä et al., 2021; Nielsen-Rodriguez et al, 2021; Pocovi et al, 2019). Opportunities to allow for more active learning and less sedentary behaviour should be encouraged (Woodfield et al., 2022). Ellis et al (2019) suggest furniture such as standing desks could also support decreasing sedentary time.

However, some research suggests that young children spend more time being physically active. In Canada, Stone et al (2019) found that children spent the majority (70.8%) of their day active and nearly all ( $\geq 97\%$ ) met physical activity guidelines. Nilsen et al (2019) and Arhab et al (2018) found that children were significantly more active whilst at their childcare setting compared with other times.

### *3.2.1.1. Factors influencing physical activity in nurseries and preschools*

Several factors were found to influence physical activity in nursery and preschool settings.

#### *Indoor vs outdoor play*

Similar to the review by McGeorge (2018), several studies have shown that opportunity to play outside is important for encouraging physical activity in young children. Indoor free play alone does not provide sufficient opportunities for young children to engage in physical activity (Koepp et al., 2022; Mazzucca et al, 2018). However, where settings had large indoor areas which were big enough for children to move and run indoors, children were more likely to meet guidelines for physical activity (Iivonen et al., 2016).

Using accelerometry data, Tandon et al (2018) showed that both boys and girls were more than twice as active outside compared to inside. They also spent less time sedentary and engaged in more LPA and MVPA when outside (Tandon et al., 2018). To meet physical activity recommendations, outdoor play opportunities should be made available, and these opportunities should be designed to reinforce the development of FMS, especially as outdoor play offers more opportunity for children to develop FMS (McConnell-Nzunga et al., 2020; Wadsworth et al, 2020).

Tandon et al (2018) found that during a day, children spent, on average, 24% of childcare time outdoors, averaging 74 min daily outdoors, with only 54% of children meeting guidelines to spend  $\geq 60$  min/day outdoors. Increasing the time available to play outdoors would support increased opportunity for physical activity. It is important that time spent outside is well-structured to encourage physical activity (Connelly et al., 2021). It is the first 10 minutes of being outdoors that contained the most physical activity, and so frequent opportunities for outdoor play should be timetabled (Bruijns et al., 2021). Additionally, offering free play opportunities during outdoor time promotes physical activity and reduces sedentary time (Tonge et al., 2020).

Some features of a physical activity-supportive environment have been identified. Children attending settings with outdoor environments including natural elements (e.g. trees, grass, plants, a hill or mound for rolling, etc) and a wider range of portable play equipment (e.g. balls, hoops, portable climbing equipment, etc) were more physically active (Gubbels et al., 2018). An outdoor environment including more natural elements was also shown to better support physical activity among more vulnerable children (e.g. those with higher anxiety). Szeszulski et al (2022) note that having more outdoor play equipment available (e.g. a range of fixed and portable play equipment) and a better quality outdoor play environment (e.g., access to shade, number of play areas, bike paths) supported physical activity and improved movement skill development. However, they note that many early years settings did not have a garden, had limited shade, and had a small number of play areas (Szeszulski et al., 2022). Luchs & Fikus (2018) support this arguing that nurseries and preschools should consider diverse outdoor designs which incorporate both natural elements alongside more contemporary play equipment (e.g. climbing frames, slides) to maximise physical activity, serving a range of activity levels. This is supported by Toussaint et al (2020).

#### [Planning activities to maximise physical activity opportunities](#)

Studies indicated the timing of activities to support physical activity was important. Nielsen-Rodríguez et al (2021) noted that the most active times for children in early years settings were break times and specific sessions targeting physical activity / physical education. In line with the studies discussed earlier, regular breaks, ideally offering outdoor play opportunities, alongside targeted sessions which incorporate physical activity (e.g. physically active learning) should be incorporated into children's timetables (Bruijns et al., 2021). Higher levels of physical activity could be promoted by improving the quality of play activities and by providing more active opportunities (Zhang et al., 2018). Boredom may contribute to increased sedentary behaviour, particularly for children who spend a lot of time in childcare settings. Varying play environments, play opportunities and play equipment might help to prevent boredom and increase physical activity (Gubbels et al., 2018).

Children are most sedentary and engage in the least MVPA during indoor activities including seatwork, mealtimes and reading, spending around 50% of their time in these three activities (Kyhälä et al., 2021). The structure of early years programmes can impact on movement behaviours and physical activity and so timetables should be carefully considered (Zhang et al., 2019). Breaking up sedentary activities like these with short break times could help. Maata et al (2019) showed children spent less time being sedentary if they had frequent breaks, although Driediger et al (2019) assessed the impact of more frequent, short outdoor playtimes and did not find any significant impact on physical activity levels. Wear time of accelerometers may have impacted these results, however, and so more research may be needed.

Outdoor play, role play, music and dance, construction play and offering activity stations have been highlighted as promoting more vigorous physical activity and reducing sedentary time

(Mazzucca et al, 2018; Battelley, 2021; Woodfield et al., 2022). Opportunities to offer these kinds of play more regularly should be considered, and wherever possible physically active learning opportunities should be presented. McGowan et al (2021) showed that engaging with cognitive tasks in an active manner (compared with doing the same tasks whilst seated) had no impact on learning but did improve children's self-regulation and reduced sedentary time. However, both Suzuki (2020) and Duncan et al (2019) also showed that physical activity improved children's cognitive abilities. Specifically, Duncan et al (2019) showed that combining movement and storytelling improved children's physical and communication development.

In relation to the time of day to best promote physical activity, the evidence is contradictory. A study by Mazzucca et al (2018) showed children are most active in the mornings and this wanes in the afternoon, however, Wiersma et al (2019) showed children were most active in the afternoon and late afternoon. The childcare context, environmental factors and child-related factors may mediate this, and so more research is needed to determine the best time of day for scheduling physically active play and learning.

### 3.2.2. Factors influencing physical activity at childminders / family childcare homes

In the 2018 review (McGeorge, 2018), the focus within the literature reviewed was centred on early years childcare settings such as nurseries and preschools. In this review, a number of papers were identified which examine other childcare settings like childminders/FCCH. In these settings, children are cared for in a family home, usually by one practitioner, with a small number of other children. In the UK, a childminder can care for up to six children under the age of 8, three of whom can be 5 years old or under and one of these three can be under 1 years old.

When comparing physical activity levels of children in early childcare education centres (ECEC; preschools and nurseries) with those attending a FCCH, Risica et al (2022) found that toddlers attending ECECs spent significantly more time playing at higher physical activity levels levels than those in FCCHs (61 minutes vs 13 minutes). McConnell-Nzunga et al (2020) found that ECEC settings had more daily engagement in physical activity practices compared with FCCH, but more FCCHs reported stated children engaged in at least 120 minutes of active play when compared to ECECs. Risica et al (2022) suggest these differences could be because providers at ECECs lead more activities than in FCCHs. It may also be due to the availability of screentime in FCCHs (Mazucca et al, 2018)

However, when examining sedentary time, at FCCHs, Chai et al (2020) showed that children accumulated mainly short sedentary bouts (<5 min and in a few cases up to 10 minutes). Boys are generally more active than girls at FCCHs, accumulating shorter and less frequent sedentary bouts than girls (Chai et al, 2020). This is in line with sex differences found in ECECs but may suggest there are sufficient opportunities for active play in FCCHs. More research is



needed to understand differences in physical activity opportunities in different childcare settings (Risica et al., 2022), particularly within a UK context.

Space to play was highlighted as a barrier to physical activity in FCCHs, particularly outdoor space. FCCHs tend to have less outdoor space, with only 1/3 reporting they had enough space for large group running games (McConnell-Nzunga et al., 2020). Children attending FCCHs with poor-quality outdoor environments have poorer activity profiles (Mazzucca et al., 2018). Features of FCCHs that achieved guidelines for at least 60 minutes of active outdoor play included: having portable play equipment, offering a variety of fixed play equipment, and/or adequate indoor play space, alongside reduced frequency and duration of sedentary bouts (Chai et al., 2020). However, because FCCHs accommodate fewer children, they can visit outdoor locations for walks (e.g. a local park) to achieve 60 minutes of outdoor play (McConnell-Nzunga et al., 2020).

Studies identified some features of FCCHs where physical activity engagement was high. This included those that had suitable outdoor and / or indoor space, had portable play equipment, offered a variety of fixed play equipment, and where measures were taken to reduce the frequency and duration of sedentary bouts (Chai et al., 2020). Increasing the duration and frequency of adult-led activities also had a positive impact on reducing screen time and improving the physical activity environment (Kao et al., 2018).

Jiang et al (2020) indicated that FCCHs do have some relevant knowledge about national child physical activity and nutrition guidelines, but that suggest that FCCHs would benefit from tailored training and support to them to overcome misperceptions and barriers to effective physical activity provision and child nutrition. This should be tailored to the cultural context (Dinkel et al, 2018; Jiang et al., 2021). Gans et al (2022) support this. In their intervention, they showed that FCCHs have less structured schedules and operate with different logistical and space constraints than ECECS, but through tailored support, guidance and feedback, physical activity practices can improve. However, more research is needed to understand FCCH environments and their impact on physical activity for young children.

### 3.2.3. Factors influencing physical activity at home

A small number of studies examined physical activity of young children in their home environments. Parental factors influencing physical activity are discussed later in this report, but studies generally showed some inconsistencies in terms of physical activity levels in a home environment compared with other early years settings.

Statler et al (2020) compared physical activity in four different childcare environments (centre-based (e.g. preschools), FCCH-based, home-based with parent, and school. No significant differences were observed in habitual daily or hourly rates of physical activity (PA) or sedentary time across these settings. Tandon et al (2017) presented similar results but showed that children engaged in more MVPA minutes per hour and had fewer sedentary minutes per hour in early childcare settings compared with at home. Nilsen et al (2019)

reported similar findings showing that children were less active during out-of-childcare hours (at home) compared with when they attended their childcare setting. Further, Carsley et al (2017) showed that children who spend more time in ECEC settings have less parent-reported outdoor free play when at home. Increased opportunities for outdoor free play and physical activity when in the home environment should be encouraged.

Unlike previous studies discussed within this report which showed sex differences in physical activity among boys and girls in ECEC and FCCH settings, Statler et al (2020) found no significant differences between boys or girls in daily or hourly rates of physical activity (MVPA and TPA) across four childcare settings, including at home (Statler et al., 2020). However, some sex differences may exist – McCullough et al (2018) showed that girls participate in more joint physical activity with their mothers than boys. As with FCCHs, more research is needed which examines the impact of the home environment on young children’s physical activity.

### 3.3. The influence of the childcare provider on physical activity

In addition to examining the impact of the childcare setting and environment on young children’s physical activity, a number of studies examined the impact of the childcare provider within those settings on children’s physical activity engagement.

#### 3.3.1. The influence of childcare practitioners in nursery and preschool settings

A range of practitioner specific factors were identified which influenced children’s physical activity in nursery and preschool settings. Many of these studies note that staff experience and training is an important mediator of physical activity for young children (Anderson et al (2020; Battelley et al, 2020; De Marco et al., 2015; Lum et al, 2021; Mazzucca et al, 2018; McConnell-Nzunga et al, 2020 Troussant et al, 2020).

Specifically, having more experienced teachers has an impact on children’s physical activity (Mazzucca et al., 2018) and the implementation of physical activity policies in settings (Lum et al., 2021). De Marco et al (2015) and Anderson et al (2020) showed that practitioner-led interventions to increase physical activity and reduce sedentary behaviour were more effective when practitioners are provided sufficient training to deliver these interventions in their settings. Training and development for practitioners is especially important in relation to developing understanding around FMS and physical literacy, where practitioner-understanding is often lacking (McConnell-Nzunga et al., 2020).

Staff interactions were also highlighted as an important mediator of physical activity. Engagement with adults (and peers) in settings can have a negative impact on physical in infants in ECEC centres (Pocovi et al., 2019; Zhang et al., 2019), toddlers and preschoolers in early years settings, nursery and reception, as there is a negative association with MVPA when

children are interacting when others (Woodfield et al., 2022). However, the importance of social interactions for broader development should be considered.

Other studies indicated that staff interactions can be important in facilitating physical activity and prompting change in children's movement behaviours (Boyle et al, 2022; Connelly et al., 2021; Tonge et al, 2021). Boyle et al (2022) showed that when staff did not join in outdoor play, children engaged in less physical activity. Connelly et al (2022) showed that staff prompting can enhance opportunities for outdoor active play, which is supported by Tonge et al (2021) who noted that quality interactions with staff resulted in increased physical activity.

Studies also showed that practitioner behaviour had an impact on children's physical activity, specifically their sedentary behaviours and MVPA. Two studies showed that the sedentary behaviour and MVPA of staff in early years settings influenced children's physical activity (Carson et al., 2020; Tonge et al., 2021). Where staff engage in more sedentary behaviour, and less MVPA, increased sedentary behaviour is also observed in children. This highlights the important influential role of the childcare practitioner on children's movement behaviours.

### 3.3.2. The influence of childminders (FCCH practitioners) on children's physical activity

Only one study examined provider-specific variables which may influence children's physical activity in FCCHs. Mazzucca et al (2018) measured practitioner physical activity alongside children's activity and found very low levels of MVPA among practitioners (MVPA totalled an average of 9 minutes during FCCH hours). Their study also showed that children who attended FCCH had poor physical activity profiles, particularly in relation to MVPA. This suggests that efforts to improve FCCH environments may need to include a focus on changing providers' attitudes toward their own physical activity to positively impact those of children in their care.

### 3.3.4. The influence of parents on children's physical activity

Several studies have identified a range of factors related to parents which influence young children's physical activity both at home and in childcare settings, including parental screentime, parental physical activity and socioeconomic factors.

#### 3.3.4.1. Parental screentime

Screentime has been shown to have a detrimental impact on young children's development, increasing sedentary time and reducing opportunity for physical activity levels (McArthur et al, 2022). Studies included in this review showed that parental screentime habits influenced the screentime habits of their young children (DeCraemer et al., 2020; Matarma et al., 2016; Frate et al., 2019). Specifically, DeCraemer et al (2020) showed that if parental screen time is low and the father attended higher education, children were more likely to meet movement guideline on weekdays (De Craemer et al., 2020). Maternal screentime has also been shown to influence the screen time of children, where mothers with higher screentime tend to have

children who also had increased screentime (Matarma et al., 2016). This is supported by Frate et al (2019) who showed that there are significant correlations between both parents' screen time and children's screentime, increasing sedentary behaviour (Frate et al., 2019). Parents report that screentime is often used as a distraction technique to allow them to complete work or undertake household jobs and chores (Josephs et al, 2019). Evidence-based guidelines for child screentime should be further researched (Steinwandt et al., 2022).

#### *3.3.4.2. Parental physical activity*

As with screentime, studies in this review showed that parental physical activity influenced the physical activity of children (Carsley et al., 2017; Carson et al., 2015; Frate et al., 2019; Hesketh et al., 2019; McCullough et al., 2018; Nilsen et al., 2019). Carson et al (2015) found that parents who take part in the least physical activity were more likely to also have children who take part in the least activity, whereas those with high levels of physical activity tend to have children with good activity profiles. This is supported by Hesketh et al (2019) who show active mothers have more active children. Parents act as role models to their children and where high levels of physical activity are observed and parents enjoy being active, children are more likely to mimic this behaviour (Frate et al, 2019)

In relation to this, parental self-efficacy was examined in a small number of studies with mixed findings. Parental self-efficacy refers to a parent's belief in their own abilities to be a good parent and influence the child in a way that promotes health and success. Kieslinger et al (2021), using parent self-report measures, showed that parental self-efficacy had a significant influence on children's physical activity and screen use in that parents with higher self-efficacy had children with higher levels of physical activity and lower screen use. However, when using rigorous measurements including accelerometry and BMI, Parekh et al (2018) found no association between parental self-efficacy and children's physical activity levels, their body composition, or cardiorespiratory fitness. More research is needed to assess the impact of parental self-efficacy on children's activity levels.

#### *3.3.4.3. Socioeconomic factors*

Three studies highlighted socioeconomic factors related to parents which influence children's physical activity (Määttä et al., 2018a, 2018b; Tandon et al., 2017). Tandon et al (2017) indicate that parents with low educational background and lower SES tend to be less comfortable with allowing their children to play outside near their home. In another study, Määttä et al (2018a) note that parents with lower educational background are more likely to engage in outdoor play alongside their children in a garden or yard, while those with higher educational backgrounds are more likely to take their children to structured indoor physical activity session. Parents, regardless of SES, are more comfortable with their child playing outside at childcare than at home (Tandon et al., 2017).

Määttä et al (2018b) showed that higher parental SES was associated with higher levels of sedentary time during preschool time for children. The preschools attended by these children tended to have a higher number of themed weeks which incorporated more sedentary time (e.g. deskwork), a lower number of themed weeks which incorporated physically active learning, and/or fewer physical education lessons. They suggest further investigation about parental SES, childcare setting choices and the influence on children's physical activity is needed.

Relatedly, some studies also investigated the influence of parent-perceived environmental factors and the impact on physical activity. Tandon et al (2017) indicated that a proportion of parents and some childcare providers believed children would get sick by playing outside in the cold. This had significant associations with MVPA and sedentary time at home (Tandon et al., 2017). Furthermore, if parents perceived their neighbourhood to be unsafe due to heavy traffic and higher neighbourhood crime, this also had a negative impact on children's active play (Bassul et al., 2021) and reduced the likelihood of meeting screen time guidelines (Baldwin et al., 2022). Availability of local green spaces is also important for the promotion of physical activity (Battelley, 2021).

### 3.4. The impact of physical activity policies and guidelines

Several studies explored the implementation of specific policies, often focused on movement behaviour and the amount of recommended physical activity, as well as stakeholders' promotion of these policies and guidelines.

#### 3.4.1. National / international physical activity guidelines

Internationally literature has focused on the 24-hour movement recommendations set out by the World Health Organization (2019), with a focus on either the benefits of or compliance to these guidelines. The 24-hour movement guidance focuses on physical activity, sedentary behaviour and sleep which was seen as a positive by many stakeholders and end user groups regardless of gender, cultural background, or profession (Riazi et al, 2017). Whilst studies have explored each of these elements (physical activity, sedentary behaviour and sleep), some also considered the interconnectedness of health, nutrition and screen time, with the latter being a significant concern for many (Riazi et al, 2017; Meredith-Jones et al., 2019; Santos et al, 2017; Staiano et al, 2018). Santos et al (2017) argued that strategies to reduce screen time are necessary, as promoting health-related behaviours in early childhood has the potential to provide children a strong foundation for lifelong physical and mental health.

Several studies illustrated that these national/international guidelines were not being met, although findings are mixed. De Craemer et al., (2018) in investigating children's compliance with the 24-hour movement behaviour guidelines, found low percentages of pre-schoolers complying with these guidelines, with the lowest compliance found for physical activity (rather than sedentary behaviour or sleep). Similarly, in Australia, Santos et al (2017) found

that in a sample of 202 toddlers, only 8.9% met the overall 24-hour movement guidelines. However, this research found that most of the sample met the physical activity (96.5%) and sleep (79.7%) guidelines but only 11.4% met the sedentary behaviour guideline. This was similar for Meredith Jones et al (2019). Santos et al (2017) suggested that BMI was not associated with the accomplishment of any of the 24-hour movement guidelines.

McGowan et al (2022) identified the benefits for adopting the 24-hour movement guidelines and integrating these into early learning standards so both families and schools can support children's capacity to meet them, supporting physical and cognitive health. They suggest an active lifestyle in early childhood may support young children's self-regulation and early educational outcomes. Furthermore, Mota et al (2020), in investigating the relationship between the 24-hour movement behaviour and FMS in preschoolers, MVPA was associated with greatest positive changes in total motor score. They suggest further research is needed to understand an adequate balance between movement behaviours over the 24-hour period, and its relationship with FMS development.

#### 3.4.2. Local / regional physical activity policies

Whilst several papers explored national and international guidelines, many also looked at the impact of physical activity policy implementation within a specific setting or context, with several agreeing that childcare policies can be a promising strategy to prevent adverse health outcomes among young people and improve physical activity (Kratch et al., 2020; McKay & Nigro, 2017; McKee et al., 2020; Slining et al., 2021; Szpunar et al., 2021).

Szpunar et al (2021) showed that an evidence-based, stakeholder-informed, written physical activity and sedentary time policy was effective for improving young children's LPA. Kratch et al (2020) examined state-wide policy changes on ECEC practices, environment, staff behaviours, and policy changes on child physical activity. They found that ECECs improved their environment over time, specifically by reducing screen time and increasing active play opportunity as guided by centre policy, which increased child physical activity. Similarly, McKee et al (2020) examined the impact of implementing several evidenced – based nutrition and physical activity policies across childcare centres in the USA and found that new practices such as serving more fruits and vegetables; eliminating sugary drinks and juice; family-style dining; healthier celebrations; limiting screen time; increasing outdoor play time; and supporting breastfeeding, were positively received by children and staff. However, some families required more support in implementing these practices, suggesting the need to work closely with families when implementing health-related policies in ECECs.

Literature recognises the importance of engaging stakeholders (including ECEC staff and families) in the development of guidelines to assess acceptability of information, barriers to uptake, and identification of key messengers and methods for dissemination (Tremblay et al, 2017). Slining et al (2021) examined the role of stakeholders in policy development using community-based participatory research to assist ECEC directors and caregivers to design

policy, systems and environmental change for improving healthy eating and physical activity. Involving key stakeholders like caregivers and ECEC staff using this approach benefitted the implementation of these policies, supporting increased physical activity among children.

McKay and Nigro (2017) also note the importance of family involvement in the implementation of physical activity and / or health related policy in ECECs. When evaluating the implementation of centre policy, they found parent engagement helped sustain organisational commitment to the guidelines. To support this, parents received information and tips that they could use for meals and activities at home.

In relation to local policies around screen time, Ott et al (2019) found that physical activity regulations are more common than screentime policies, although less than half of the participating settings in their study implemented a physical activity policy and only a third adopt screentime regulations. The authors conclude by suggesting a need to advance practice by adopting proactive approaches to encouraging young children to be more active and less sedentary in childcare, through written policies. Supplementing policy with accessible resources and consistent staff training are important for policy implementation and adherence (Ott et al, 2019).

Similarly, Brye-Williams et al, (2019) found that less than half of the non-Head Start (equivalent to Sure Start in the UK) ECECs in their research met recommendations for physical activity and outdoor learning, recommending that resources are dedicated to helping ECECs to enact and modify written policies and to implement programs to improve their outdoor learning environments so that physical activity can be promoted.

Taken together, facilitators to policy adherence include taking a comprehensive approach to healthy living changes and building changes over time; effective communication with staff and parents so a consistent approach is taken; and working closely with families to implement change (McKee et al, 2020). There could be logistical barriers that impede ongoing training and support for centre staff regarding policy, but online e-modules can address some of these barriers (McKay & Nigro, 2017).

However, much of the research, argues that further policy research is required to identify how childcare settings can provide and be supported to provide adequate opportunities for physical activity participation (Szpunar et al, 2021); obesity prevention environments (Lum et al, 2020) and how policy can offer guidance and support in early years contexts (Finch et al, 2019).

### 3.5. Physical activity in infants (up to 24 months)

The first 1001 days have been cited as key for infant health. Physical activity is important at this time to support the health of both infant and parents, although a lack of support and motivation have been identified as barriers to physical activity during this time (Lovett, 2022). World Health Organisation (2019) recommendations for children under two years old state

that physical activity should include tummy time, that sedentary behaviour through a) screen time and b) time spent in restraint (e.g., pushchair or car seat) should be limited and infants should get high quality sleep of between 11 and 17 hours per day (including naps). Meeting guidelines for these behaviours could be key to children's physical activity as they develop through childhood and beyond (Xu et al., 2016).

From birth, in the majority of cases, parents act as gatekeepers for physical activity. In the UK, parents reported that for infants under 12 months old, less than a third met recommendations for tummy time (Hesketh & Janssen, 2022). For childcare providers in the USA, Canada and Australia, most were compliant with recommendations to encourage physical activity for those under six months old for the daily provision of supervised tummy time to allow for free movement (Hewitt et al., 2018). They were also compliant with the use of play in both indoor and outdoor environments to encourage physical activity and discouraged the use of screens. However, compliance was low in all three locations when it came to the education provisions in place for families about children's physical activity (Hewitt et al., 2018). Encouraging and supporting childcare providers to be more proactive in educating parents would support more children meeting the guidelines at this key age. However, it is recognised that there may be limited opportunity to reach parents of infants under the age of 2 through childcare providers in the UK. Currently in the UK, before the age of 2, children are not eligible for free hours of childcare, and even at 2 years of age only 74% of families take up these hours (Gov.uk, 2023), meaning many infants are cared for outside of formal childcare settings. More research is needed to understand physical activity behaviours of infants cared for at home or outside of formal childcare settings.

Similar to research with toddlers and preschoolers, by monitoring how infants spend their time in ECEC centres using behaviour-mapping techniques, meal areas were identified as a space where infants spent most of their time but that they were also more sedentary in this location (Pocovi et al., 2019). Infants were found to be most active in the indoor play area (Pocovi et al., 2019). Infants displayed more sedentary behaviour whilst engaged with others (peers or carers) than when not, this would be an area of further research (Pocovi et al., 2019).

#### 4. Conclusion

The purpose of this review was to examine literature published since 2017 to bring the evidence base surrounding physical activity in children under 5 years of age up to date. In doing so, we intended to identify key barriers and facilitators to physical activity, physical literacy, physical development and active play for children in the early years.

This was in response to a review developed by McGeorge (2018), which considered literature up to 2017, developing 7 promising principles to facilitate physical activity in children under 5 in early years settings. These promising principles were:



1. Ensure practitioners receive appropriate training and support which improves their knowledge and understanding about physical activity and sedentary behaviour and increases their confidence to support physical activity.
2. Create an ethos and environment that supports physical activity, whereby settings:
  - Have a written physical activity policy in place
  - Promote positive staff behaviour including prompting children to be active, playing with children, encouraging and acknowledging children's physical activity
  - Where possible, decrease playground density (the number of children per square metre)
  - Provide portable play equipment
  - Limit sedentary opportunities (e.g. reduce screentime) and modify the environment to support activity
  - Provide appropriate space for physical activity that maximises the potential of the available area (both indoors and outdoors)
  - Provide more frequent periods of outdoor play
3. Include a balance of child initiated and adult led physical activities.
4. Provide structured physical activity which supports the development of fundamental movement skills.
5. Integrate physical activity into daily routines and use it to support other areas of learning and development.
6. Involve parents and carers, raising their knowledge and awareness of physical activity, sharing activity ideas with them and encouraging them to build on the physical activities introduced in settings.
7. Deliver multi-component interventions (including a range of the areas outlined above).

The literature reviewed in this report supports the promising principles identified by McGeorge (2018) in relation to facilitating physical activity in early years settings, like nurseries and preschools (ECECs). Most of the literature reviewed related to physical activity in these settings and showed that active play (particularly outdoor play) was important for physical activity, and features of activity supportive environments were identified, including outdoors spaces which included natural elements and provision of portable play equipment. Settings with larger indoor spaces were viewed as activity supportive. The range of play activities on offer was also important, with recommendations to include more activities which promote movement, such as construction play, role play, music and dance. Screentime is a concern, negatively impacting physical activity; thus, measures should be taken to reduce

screen use in early years settings. Furthermore, settings with written physical activity policies, or policies focusing on health-related behaviours seemed to support increased physical activity among children. Finally, factors related to staff were found to influence children's physical activity, such as staff training and experience, and their interactions with children during activities and play.

Some more nuanced recommendations can also be drawn from this review in relation to ECECs. First, where interventions are being implemented which focus on physical activity, FMS development should also be considered. Features of successful interventions might include those which do not require significant time for delivery, do not require specialist equipment, require minimal training and can be delivered by ECEC practitioners. Building in child autonomy and a mastery-motivated climate can also help facilitate the development of movement skills and increase physical activity. Where possible, interventions should support the development or implementation of physical activity policies, and families should be informed with resources to enhance consistency across settings.

Next, the reviewed literature suggests that there are sex differences in physical activity in ECECs, where boys tend to be more active and may benefit more from the physical activity offerings in these settings. This should be given more consideration with regard to physical activity interventions, policies and ECEC environment development. Finally, the timing and frequency of activities to promote physical activity requires more research.

This review also extends the work of McGeorge (2018) in relation to physical activity outside of ECEC settings. It provides emerging evidence about the state of physical activity opportunities presented at home alongside parents, and in family-based childcare (FCCH) settings, such as childminders. In doing so, it has identified a number of factors which might influence physical activity, physical development and active play in these settings.

In FCCHs, the literature showed that children who attend these settings may be less physically active than those attending ECECs, and again, screentime was a potential mediating factor in relation to this. The main barrier to physical activity in FCCHs was a lack of outdoor space, although FCCHs do have the opportunity to take children out of the home to public spaces like parks, where activity recommendations can potentially be more easily met. Facilitators to physical activity in FCCHs were similar to ECECs, in that those who offered portable play equipment, had adequate indoor and / or outdoor space and actively reduced sedentary bouts were more likely to have children who met the recommended levels of physical activity. Education of FCCH practitioners was highlighted as an important recommendation for improving the physical activity of children who attend these settings; however, only a small number of studies have examined physical activity of young children in these settings, and all of those were based in North America (USA and Canada), so more research within a UK context is necessary.

In relation to physical activity at home and with parents, again, the literature was relatively limited. The available literature suggested that children may be less active at home compared

to ECEC settings and, as with ECECs, sex differences in physical activity at home seem to exist. However, more research is needed in relation to this. Key barriers to physical activity at home related to parental screentime, where if parents had higher screen time use so did their children, which reduced physical activity overall. Parental physical activity was also an important facilitator to child physical activity, where more active parents had more active children, and parental self-efficacy was identified as a mediator. Thus, parental support to reduce screentime and increase physical activity alongside their children is recommended but, again, caution should be taken given the small number of studies speaking to these issues.

Socioeconomic factors were also examined in relation to physical activity at home, with research suggesting socioeconomic status to be a predictor of parental perceptions around children's play and activity both at home and in ECEC settings, but again, more research is needed in relation to this.

Finally, this review presented some, albeit limited, evidence in relation to physical activity in infancy (children aged 2 and under). In relation to this, it was highlighted that in early years centres, like nurseries, there is some understanding surrounding physical activity guidelines and recommendations for very young children and babies. However, research suggests that only a minority of parents adhere to guidelines surrounding tummy time, and that there is a need for support and communication between settings and parents/carers to facilitate a better understanding of the importance of tummy time, limiting sedentary activities (such as screentime and time spent in restraint), and good quality sleep for physical development and future physical activity. Given the very limited evidence available in relation to physical activity in infancy, more research is needed to better understand facilitators and barriers to physical activity for this age group.

Thus, in addition to providing evidence to support the promising principles proposed by McGeorge (2018), this review has also identified gaps within the literature where more evidence is needed to better understand how to facilitate quality physical activity and support physical development in children under the age of 5. Key areas of focus include:

- Differences between childcare settings, with a focus on understanding physical activity in FCCHs and home settings, within a UK context.
- Effective training mechanisms to improve childcare provider knowledge and understanding surrounding physical activity and, importantly, FMS.
- Sex differences in relation to physical activity across different childcare settings.
- Activities, curricula and policy guidelines to support the development of FMS and increase physical activity in young children, within a UK context.
- Physical activity and development in infancy, specifically in relation to parental understanding and effective practice in childcare settings.

## 5. References

- Andersen, E., Øvreås, S., Jørgensen, K. A., Borch-Jensen, J., & Moser, T. (2020). Children's physical activity level and sedentary behaviour in Norwegian early childhood education and care: effects of a staff-led cluster-randomised controlled trial. *BMC Public Health*, *20*(1), 1–10. <https://doi.org/10.1186/s12889-020-09725-y>
- Arhab, A., Messerli-Bürgy, N., Kakebeeke, T. H., Lanzi, S., Stülb, K., Zysset, A. E., Leeger-Aschmann, C. S., Schmutz, E. A., Meyer, A. H., Munsch, S., Kriemler, S., Jenni, O. G., & Puder, J. J. (2018). Childcare correlates of physical activity, sedentary behaviour, and adiposity in preschool children: A cross-sectional analysis of the splashy study. *Journal of Environmental and Public Health*, *2018*(Cc). <https://doi.org/10.1155/2018/9157194>
- Baldwin, J., Arundell, L., & Hnatiuk, J. A. (2022). Associations between the neighbourhood social environment and preschool children's physical activity and screen time. *BMC Public Health*, *22*(1), 1–10. <https://doi.org/10.1186/s12889-022-13493-2>
- Bassul, C., Corish, C. A., & Kearney, J. M. (2021). Associations between Neighborhood Deprivation Index, Parent Perceptions and Preschooler Lifestyle Behaviors. *Children*, *8*(11). <https://doi.org/10.3390/CHILDREN8110959>
- Battelley, H. (2020) *Exploring reception teachers' perceptions of physical activity and physical development practice*. Unpublished: Available on request
- Battelley, H. (2021) "How does an intervention strategy around physical activity and movement influence parent/carers' perceptions of early childhood movement play?". MA, Birmingham City University. Available at: <http://www.crec.co.uk/research-paper-archive/>
- Bourke, M., Vanderloo, L. M., Irwin, J. D., Burke, S. M., Johnson, A. M., Driediger, M., Timmons, B. W., & Tucker, P. (2022). Association between childcare movement behaviour compositions with health and development among preschoolers: Finding the optimal combinations of physical activities and sedentary time. *Journal of Sports Sciences*, *40*(18), 2085–2094. <https://doi.org/10.1080/02640414.2022.2134969>
- Boyle, M. H., Olsho, L. E. W., Mendelson, M. R., Stidsen, C. M., Logan, C. W., Witt, M. B., Gola, A. A. H., & Copeland, K. A. (2022). Physical Activity Opportunities in US Early Child Care Programs. *Pediatrics*, *149*(6). <https://doi.org/10.1542/peds.2020-048850>
- Bruijns, B. A., Vanderloo, L. M., Timmons, B. W., & Tucker, P. (2021). Exploring preschoolers' physical activity and sedentary time during outdoor play at childcare: A cross-sectional analysis of the supporting physical activity in the childcare environment study. *Journal of Physical Activity and Health*, *18*(8), 949–956. <https://doi.org/10.1123/jpah.2020-0849>
- Buckler, E. J., Mâsse, L. C., Faulkner, G. E., Puterman, E., McConnell-Nzunga, J., & Naylor, P.-J. (2022). Implementing active play standards: a qualitative study with licensed childcare

- providers in British Columbia, Canada. *Health Promotion International*.  
<https://doi.org/10.1093/HEAPRO/DAAC036>
- Cairney, J., Dudley, D., Kwan, M., Bulten, R., & Kriellaars, D. (2019). Physical literacy, physical activity and health: Toward an evidence-informed conceptual model. *Sports Medicine*, 49, 371-383.
- Carsley, S., Liang, L. Y., Chen, Y., Parkin, P., Maguire, J., & Birken, C. S. (2017). The impact of daycare attendance on outdoor free play in young children. *Journal of Public Health (United Kingdom)*, 39(1), 145–152. <https://doi.org/10.1093/pubmed/fdw006>
- Carson, V., Adamo, K. B., Ogden, N., Goldfield, G. S., Okely, A. D., Kuzik, N., Crozier, M., Hunter, S., & Predy, M. (2020). Sedentary Time and Physical Activity Associations Between Child Care Educators and Children. *American Journal of Preventive Medicine*, 58(4), e105–e111. <https://doi.org/10.1016/j.amepre.2019.11.016>
- Carson, V., Stearns, J., & Janssen, I. (2015). The relationship between parental physical activity and screen time behaviours and the behaviors of their young children. *Pediatric Exercise Science*, 27(3), 390–395. <https://doi.org/10.1123/pes.2014-0214>
- Chai, L. K., Rice-Mcneil, K., & Trost, S. G. (2020). Patterns and correlates of sedentary behaviour in children attending family childcare. *International Journal of Environmental Research and Public Health*, 17(2), 1–10. <https://doi.org/10.3390/ijerph17020549>
- Connelly, J. A., Manningham, S., & Champagne, M. (2021). Factors Related to Energetic Play During Outdoor Time in Childcare Centres. *Early Childhood Education Journal*, 49(3), 441–449. <https://doi.org/10.1007/s10643-020-01088-8>
- De Craemer, M., McGregor, D., Androutsos, O., Manios, Y., & Cardon, G. (2018). Compliance with 24-h movement behaviour guidelines among Belgian preschool children: The toybox-study. *International Journal of Environmental Research and Public Health*, 15(10), 1–10. <https://doi.org/10.3390/ijerph15102171>
- De Craemer, M., Verbestel, V., Cardon, G., Androutsos, O., Manios, Y., & Chastin, S. (2020). Correlates of meeting the physical activity, sedentary behaviour, and sleep guidelines for the early years among Belgian preschool children: The toybox-study. *International Journal of Environmental Research and Public Health*, 17(19), 1–15. <https://doi.org/10.3390/ijerph17197006>
- De Marco, A. C., Zeisel, S., & Odom, S. L. (2015). An Evaluation of a Program to Increase Physical Activity for Young Children in Child Care. *Early Education and Development*, 26(1), 1–21. <https://doi.org/10.1080/10409289.2014.932237>
- Dinkel, D., Dev, D., Guo, Y., Hulse, E., Rida, Z., Sedani, A., & Coyle, B. (2018). Improving the physical activity and outdoor play environment of family child care homes in Nebraska through go nutrition and physical activity self-assessment for child care. *Journal of Physical Activity and Health*, 15(10), 730-736.

- Driediger, M., Truelove, S., Johnson, A. M., Vanderloo, L. M., Timmons, B. W., Burke, S. M., ... & Tucker, P. (2019). The impact of shorter, more frequent outdoor play periods on preschoolers' physical activity during childcare: A cluster randomized controlled trial. *International journal of environmental research and public health*, 16(21), 4126.
- Duncan, M., Cunningham, A., & Eyre, E. (2019). A combined movement and story-telling intervention enhances motor competence and language ability in pre-schoolers to a greater extent than movement or story-telling alone. *European Physical Education Review*, 25(1), 221-235.
- Duncombe, R., & Preedy, P. (2021). Physical development in the early years: exploring its importance and the adequacy of current provision in the United Kingdom. *Education 3-13*, 49(8), 920–934. <https://doi.org/10.1080/03004279.2020.1817963>
- Ellis, Y. G., Cliff, D. P., Howard, S. J., & Okely, A. D. (2019). Feasibility, acceptability, and potential efficacy of a childcare-based intervention to reduce sitting time among preschoolers: A pilot randomised controlled trial. *Journal of Sports Sciences*, 37(2), 146–155. <https://doi.org/10.1080/02640414.2018.1486362>
- Ezeugwu, V. E., Mandhane, P. J., Hammam, N., Brook, J. R., Tamana, S. K., Hunter, S., Chikuma, J., Lefebvre, D. L., Azad, M. B., Moraes, T. J., Subbarao, P., Becker, A. B., Turvey, S. E., Rosu, A., Sears, M. R., & Carson, V. (2021). Influence of Neighborhood Characteristics and Weather on Movement Behaviors at Age 3 and 5 Years in a Longitudinal Birth Cohort. *Journal of Physical Activity and Health*, 18(5), 571–579. <https://doi.org/10.1123/JPAH.2020-0827>
- Frate, N., Jenull, B., & Birnbacher, R. (2019). Like father, like son. Physical Activity, Dietary Intake, and Media Consumption in Preschool-Aged Children. *International Journal of Environmental Research and Public Health*, 16(3), 306. <https://doi.org/10.3390/ijerph16030306>
- Gu, X. (2016). Fundamental motor skill, physical activity, and sedentary behaviour in socioeconomically disadvantaged kindergarteners. *Psychology, Health and Medicine*, 21(7), 871–881. <https://doi.org/10.1080/13548506.2015.1125007>
- Gubbels, J. S., van Kann, D. H. H., Cardon, G., & Kremers, S. P. J. (2018). Activating childcare environments for all children: The importance of children's individual needs. *International Journal of Environmental Research and Public Health*, 15(7). <https://doi.org/10.3390/ijerph15071400>
- Hall, C. J., Eyre, E. L., Oxford, S. W., & Duncan, M. J. (2018). Relationships between motor competence, physical activity, and obesity in British preschool aged children. *Journal of Functional Morphology and Kinesiology*, 3(4), 57.
- Hesketh, K. R., Brage, S., Cooper, C., Godfrey, K. M., Harvey, N. C., Inskip, H. M., Robinson, S. M., & Van Sluijs, E. M. F. (2019). The association between maternal-child physical activity levels at the transition to formal schooling: Cross-sectional and prospective

- data from the Southampton Women's Survey. *International Journal of Behavioral Nutrition and Physical Activity*, 16(1), 1–9. <https://doi.org/10.1186/s12966-019-0782-9>
- Hesketh, K. R., & Janssen, X. (2022). Movement behaviours and adherence to guidelines: perceptions of a sample of UK parents with children 0–18 months. *International Journal of Behavioral Nutrition and Physical Activity*, 19(1), 1–7. <https://doi.org/10.1186/s12966-022-01300-5>
- Hewitt, L., Benjamin-Neelon, S. E., Carson, V., Stanley, R. M., Janssen, I., & Okely, A. D. (2018). Childcare centre adherence to infant physical activity and screen time recommendations in Australia, Canada and the United States: An observational study. *INFANT BEHAVIOR & DEVELOPMENT*, 50, 88–97. <https://doi.org/10.1016/j.infbeh.2017.11.008>
- Iivonen, S., Sääkslahti, A. K., Mehtälä, A., Villberg, J. J., Soini, A., & Poskiparta, M. (2016). Directly observed physical activity and fundamental motor skills in four-year-old children in daycare. *European Early Childhood Education Research Journal*, 24(3), 398–413. <https://doi.org/10.1080/1350293X.2016.1164398>
- Jiang, Q., Tovar, A., Risica, P. M., Cooksey Stowers, K., Schwartz, M., Lombardi, C., Kang, A., Mena, N. Z., & Gans, K. M. (2021). Ethnic Differences in Family Childcare Providers' Nutrition- And Activity-Related Attitudes and Barriers. *Journal of Obesity*, 2021. <https://doi.org/10.1155/2021/6697006>
- Joseph, E. D., Kracht, C. L., Romain, J. S., Allen, A. T., Barbaree, C., Martin, C. K., & Staiano, A. E. (2019). Young children's screen time and physical activity: Perspectives of parents and early care and education centre providers. *Global Pediatric Health*, 6, 1–13. <https://doi.org/10.1177/2333794X19865856>
- Kao, J., Woodward-Lopez, G., Kuo, E. S., James, P., Becker, C. M., Lenhart, K., Boyle, K., Williamson, D., & Rauzon, S. (2018). Improvements in Physical Activity Opportunities: Results From a Community-Based Family Child Care Intervention. *American Journal of Preventive Medicine*, 54(5), S178–S185. <https://doi.org/10.1016/j.AMEPRE.2018.01.005>
- Kieslinger, K., Wartha, O., Pollatos, O., Steinacker, J. M., & Kobel, S. (2021). Parental Self-Efficacy—A Predictor of Children's Health Behaviors? Its Impact on Children's Physical Activity and Screen Media Use and Potential Interaction Effect Within a Health Promotion Program. *Frontiers in Psychology*, 12(August), 1–12. <https://doi.org/10.3389/fpsyg.2021.712796>
- Koepf, A. E., Gershoff, E. T., Castelli, D. M., & Bryan, A. E. (2022). Total Play Time Needed for Preschoolers to Reach Recommended Amount of Non-Sedentary Activity. *International Journal of Environmental Research and Public Health*, 19(6). <https://doi.org/10.3390/ijerph19063354>

- Kuzik, N., Naylor, P. J., Spence, J. C., & Carson, V. (2020). Movement behaviours and physical, cognitive, and social-emotional development in preschool-aged children: Cross-sectional associations using compositional analyses. *PLoS ONE*, *15*(8 August), 1–16. <https://doi.org/10.1371/journal.pone.0237945>
- Kyhälä, A. L., Reunamo, J., & Valtonen, J. O. (2021). Children's time use and moderate-to-vigorous physical activity in early childhood education and care in Finland. *South African Journal of Childhood Education*, *11*(1), 1–8. <https://doi.org/10.4102/sajce.v11i1.933>
- Lafave, L., Webster, A. D., & McConnell, C. (2021). Impact of COVID-19 on early childhood educator's perspectives and practices in nutrition and physical activity: A qualitative study. *Early Childhood Education Journal*, *49*(5), 935-945.
- Lovett, E. (2022). *Evidence Report: Conception to Age Two, New Parents, Physical Activity and Mental Health*. Ormskirk: Edge Hill University.
- Luchs, A., & Fikus, M. (2018). Differently designed playgrounds and preschoolers' physical activity play. *Early Child Development and Care*, *188*(3), 281–295. <https://doi.org/10.1080/03004430.2016.1213726>
- Lum, M., Grady, A., Falkiner, M., Jones, J., Finch, M., Green, S., Herrmann, V., Hall, A., & Yoong, S. (2021). Assessing the implementation of healthy eating and physical activity policies and practices in the family day care setting: A cross-sectional study. *Health Promotion Journal of Australia*, *32*(S2), 116–125. <https://doi.org/10.1002/hpja.420>
- Määttä, S., Ray, C., Vepsäläinen, H., Lehto, E., Kaukonen, R., Ylönen, A., & Roos, E. (2018a). Parental education and preschool children objectively measured sedentary time: The role of co-participation in physical activity. *International Journal of Environmental Research and Public Health*, *15*(2), 1–14. <https://doi.org/10.3390/ijerph15020366>
- Määttä, S., Konttinen, H., Lehto, R., Haukkala, A., Erkkola, M., & Roos, E. (2018b). Preschool environmental factors, parental socioeconomic status, and children's sedentary time: An examination of cross-level interactions. *International Journal of Environmental Research and Public Health*, *16*(1). <https://doi.org/10.3390/ijerph16010046>
- Machado-Rodrigues, A. M., Rodrigues, D., Gama, A., Nogueira, H., Silva, M.-R. G., Mascarenhas, L. P., & Padez, C. (2021). Objectively measured sedentary time and physical activity levels in a sample of preschool children: amounts and obesity risk. *Minerva Pediatrics*. <https://doi.org/10.23736/S2724-5276.21.06584-8>
- Malden, S., Reilly, J. J., Hughes, A., Bardid, F., Summerbell, C., De Craemer, M., Cardon, G., Androutsos, O., Manios, Y., & Gibson, A.-M. (2020). Assessing the acceptability of an adapted preschool obesity prevention programme: ToyBox-Scotland. *Child: Care, Health and Development*, *46*(2), 213–222. <https://doi.org/10.1111/cch.12736>



- Matarma, T., Koski, P., Löyttyniemi, E., & Lagström, H. (2016). The factors associated with toddlers' screen time change in the STEPS Study: A two-year follow-up. *Preventive Medicine, 84*, 27–33. <https://doi.org/10.1016/j.ypmed.2015.12.014>
- Mazzucca, S., Hales, D., Evenson, K. R., Ammerman, A., Tate, D. F., Berry, D. C., & Ward, D. S. (2018). Physical activity opportunities within the schedule of early care and education centres. *Journal of Physical Activity and Health, 15*(2), 73–81. <https://doi.org/10.1123/jpah.2017-0071>
- Mazzucca, S., Neshteruk, C., Burney, R., Vaughn, A. E., Hales, D., Ostbye, T., & Ward, D. (2018). Physical Activity and Sedentary Behaviors of Children in Family Child Care Homes: Are There Opportunities for Improvement? *PEDIATRIC EXERCISE SCIENCE, 30*(4), 529–536. <https://doi.org/10.1123/pes.2018-0040>
- McArthur, B. A., Volkova, V., Tomopoulos, S., & Madigan, S. (2022). Global prevalence of meeting screen time guidelines among children 5 years and younger: a systematic review and meta-analysis. *JAMA pediatrics*.
- McConnell-Nzunga, J., Mâsse, L. C., Buckler, E. J., Carson, V., Faulkner, G. E., Lau, E. Y., McKay, H. A., Temple, V. A., Wolfenden, L., & Naylor, P. J. (2020). Prevalence and relationships among physical activity policy, environment, and practices in licensed childcare centres from a manager and staff perspective. *International Journal of Environmental Research and Public Health, 17*(3). <https://doi.org/10.3390/ijerph17031064>
- McConnell-Nzunga, J., Weatherson, K. A., Masse, L., Carson, V., Faulkner, G., Lau, E., McKay, H., Temple, V., Wolfenden, L., & Naylor, P. J. (2020). Childcare setting and its association with policies and practices that promote physical activity and physical literacy in the early years in British Columbia. *Journal of Physical Activity and Health, 17*(4), 429–434. <https://doi.org/10.1123/jpah.2019-0215>
- McCullough, A. K., Duch, H., & Garber, C. E. (2018). Interactive Dyadic Physical Activity and Spatial Proximity Patterns in 2-Year-Olds and Their Parents. *Children, 5*(12), 167. <https://doi.org/10.3390/children5120167>
- McGowan, A. L., Gerde, H. K., Pfeiffer, K. A., & Pontifex, M. B. (2022). Meeting 24-hour movement behaviour guidelines in young children: Improved quantity estimation and self-regulation. *Early Education and Development, 00*(00), 1–28. <https://doi.org/10.1080/10409289.2022.2056694>
- Meredith-Jones, K., Galland, B., Haszard, J., Gray, A., Sayers, R., Hanna, M., Taylor, B., & Taylor, R. (2019). Do young children consistently meet 24-h sleep and activity guidelines? A longitudinal analysis using actigraphy. *International Journal of Obesity 2019 43:12, 43*(12), 2555–2564. <https://doi.org/10.1038/s41366-019-0432-y>
- Miguelles, J. H., Delisle Nyström, C., Dumuid, D., Leppänen, M. H., Henriksson, P., & Löf, M. (2023). Longitudinal associations of movement behaviours with body composition and physical fitness from 4 to 9 years of age: structural equation and mediation analysis

- with compositional data. *International Journal of Behavioral Nutrition and Physical Activity*, 20(1), 1–13. <https://doi.org/10.1186/s12966-023-01417-1>
- Mota, J. A. P. S. J. G., Clark, C. C. T., Bezerra, T. A., Lemos, L., Reuter, C. P., Mota, J. A. P. S. J. G., Duncan, M. J., & Martins, C. M. D. L. (2020). Twenty-four-hour movement behaviours and fundamental movement skills in preschool children: A compositional and isotemporal substitution analysis. *Journal of Sports Sciences*, 38(18), 2071–2079. <https://doi.org/10.1080/02640414.2020.1770415>
- Nielsen-Rodríguez, A., Romance, R., Carlos Dobado-Castañeda, J., Arufe-Giráldez, V., Navarro Patón, R., & Sanmiguel-Rodríguez, A. (2021). Teaching Methodologies and School Organization in Early Childhood Education and Its Association with Physical Activity. *Int. J. Environ. Res. Public Health*, 18, 3836. <https://doi.org/10.3390/ijerph18073836>
- Nilsen, A. K. O., Anderssen, S. A., Resaland, G. K., Johannessen, K., Ylvisaaker, E., & Aadland, E. (2019). Boys, older children, and highly active children benefit most from the preschool arena regarding moderate-to-vigorous physical activity: A cross-sectional study of Norwegian preschoolers. *Preventive Medicine Reports*, 14(November 2018), 100837. <https://doi.org/10.1016/j.pmedr.2019.100837>
- Parekh, N., Henriksson, P., Delisle Nyström, C., Silfvernagel, K., Ruiz, J. R., Ortega, F. B., Pomeroy, J., & Löf, M. (2018). Associations of Parental Self-Efficacy With Diet, Physical Activity, Body Composition, and Cardiorespiratory Fitness in Swedish Preschoolers: Results From the MINISTOP Trial. *Health Education & Behavior*, 45(2), 238–246. <https://doi.org/10.1177/1090198117714019>
- Pocovi, N., Colliver, Y., Pacey, V., Liao, J., O’Laco, E., Shepherd, R., & Scrivener, K. (2019). Analysis of infant physical activity in the childcare environment: An observational study. *Infant Behavior and Development*, 57(July). <https://doi.org/10.1016/j.infbeh.2019.101338>
- Preedy, P., Duncombe, R., & Gorely, T. (2022). Physical development in the early years: The impact of a daily movement programme on young children’s physical development. *Education 3-13*, 50(3), 289-303.
- Risica, P. M., Karpowicz, J. M., von Ash, T., Gans, K. M., Stowers, K. C., & Tovar, A. (2022). Feeding and Activity Environments for Infants and Toddlers in Childcare Centers and Family Childcare Homes in Southeastern New England. *International Journal of Environmental Research and Public Health*, 19(15). <https://doi.org/10.3390/ijerph19159702>
- Robatsch, J., Voitl, P., & Diesner-Treiber, S. C. (2021). A cross-sectional, exploratory survey on health-relevant free-time activities and body mass index in preschool children in urban and rural settings of Austria. *BMC Pediatrics*, 21(1), 1–10. <https://doi.org/10.1186/s12887-021-02972-x>

- Santos, R., Zhang, Z., Pereira, J. R., Sousa-Sá, E., Cliff, D. P., & Okely, A. D. (2017). Compliance with the Australian 24-hour movement guidelines for the early years: Associations with weight status. *BMC Public Health*, *17*(Suppl 5). <https://doi.org/10.1186/s12889-017-4857-8>
- Slining, M., Wills, S., Fair, M., Stephenson, J., Knobel, S., Pearson, M., Prostko, T., Smyers, J., Timberlake, J., & Negrete, M. (2021). LiveWell in early childhood: results from a two-year pilot intervention to improve nutrition and physical activity policies, systems and environments among early childhood education programs in South Carolina. *BMC Public Health*, *21*(1), 919. <https://doi.org/10.1186/s12889-021-10975-7>
- Staiano, A. E., Webster, E. K., Allen, A. T., Jarrell, A. R., & Martin, C. K. (2018). Screen-Time Policies and Practices in Early Care and Education Centers in Relationship to Child Physical Activity. *Childhood Obesity*, *14*(6), 341–348. <https://doi.org/10.1089/chi.2018.0078>
- Statler, J., Wilk, P., Timmons, B. W., Colley, R., & Tucker, P. (2020). Habitual physical activity levels and sedentary time of children in different childcare arrangements from a nationally representative sample of Canadian preschoolers. *Journal of Sport and Health Science*, *9*(6), 657–663. <https://doi.org/10.1016/j.jshs.2019.03.009>
- Stienwandt, S., Cameron, E. E., Soderstrom, M., Casar, M., Le, C., & Roos, L. E. (2022). Family Factors Associated with Hands-On Play and Screen Time During the COVID-19 Pandemic. *Child and Youth Care Forum*, *51*(6), 1091–1115. <https://doi.org/10.1007/s10566-021-09668-4>
- Stone, M. R., Houser, N. E., Cawley, J., Kolen, A. M., Rainham, D., Rehman, L., Turner, J., & Kirk, S. F. L. (2019). Accelerometry-measured physical activity and sedentary behaviour of preschoolers in Nova Scotia, Canada. *Applied Physiology, Nutrition and Metabolism*, *44*(9), 1005–1011. <https://doi.org/10.1139/apnm-2018-0683>
- Szeszulski, J., Lorenzo, E., Todd, M., O'Connor, T. M., Hill, J., Shaibi, G. Q., Vega-López, S., Buman, M. P., Hooker, S. P., & Lee, R. E. (2022). Early Care and Education Center Environmental Factors Associated with Product-and Process-Based Locomotor Outcomes in Preschool-Age Children. *International Journal of Environmental Research and Public Health*, *19*(4), 1–13. <https://doi.org/10.3390/ijerph19042208>
- Tandon, P. S., Saelens, B. E., & Copeland, K. A. (2017). A comparison of parent and childcare provider's attitudes and perceptions about preschoolers' physical activity and outdoor time. *Child: Care, Health and Development*, *43*(5), 679–686. <https://doi.org/10.1111/cch.12429>
- Tandon, P. S., Saelens, B. E., Zhou, C., & Christakis, D. A. (2018). A comparison of Preschoolers' physical activity indoors versus outdoors at childcare. *International Journal of Environmental Research and Public Health*, *15*(11). <https://doi.org/10.3390/ijerph15112463>

- Tonge, K., Jones, R. A., & Okely, A. D. (2020). Environmental influences on children's physical activity in early childhood education and care. *Journal of Physical Activity and Health*, 17(4), 423–428. <https://doi.org/10.1123/jpah.2019-0119>
- Tonge, K. L., Jones, R. A., & Okely, A. D. (2021). The relationship between educators and children's physical activity and sedentary behaviour in early childhood education and care. *Journal of Science and Medicine in Sport*, 24(6), 580–584. <https://doi.org/10.1016/j.jsams.2021.02.003>
- Toussaint, N., Streppel, M. T., Mul, S., Fukkink, R. G., Weijs, P. J. M., & Janssen, M. (2020). The effects of the playtod program on children's physical activity at preschool playgrounds in a deprived urban area: A randomized controlled trial. *International Journal of Environmental Research and Public Health*, 17(1), 1–13. <https://doi.org/10.3390/ijerph17010329>
- Tremblay, M. S. (2020). Introducing 24-hour movement guidelines for the early years: a new paradigm gaining momentum. *Journal of Physical Activity and Health*, 17(1), 92–95.
- Tsuda, E., Goodway, J. D., Famelia, R., & Brian, A. (2020). Relationship Between Fundamental Motor Skill Competence, Perceived Physical Competence and Free-Play Physical Activity in Children. *Research Quarterly for Exercise and Sport*, 91(1), 55–63. <https://doi.org/10.1080/02701367.2019.1646851>
- van de Kolk, I., Goossens, A., Gerards, S., Kremers, S., Manders, R., & Gubbels, J. (2018). Healthy Nutrition and Physical Activity in Childcare: Views from Childcare Managers, Childcare Workers and Parents on Influential Factors. *International Journal of Environmental Research and Public Health*, 15(12), 2909. <https://doi.org/10.3390/ijerph15122909>
- Vega-Perona, H., Estevan, I., García-Ochoa, Y. C., Martínez-Bello, D. A., Bernabé-Villodre, M. D. M., & Martínez-Bello, V. E. (2022). Role of Spanish Toddlers' Education and Care Institutions in Achieving Physical Activity Recommendations in the COVID-19 Era: A Cross-Sectional Study. *Children*, 9(1). <https://doi.org/10.3390/children9010051>
- Wadsworth, D. D., Johnson, J. L., Carroll, A. V., Pangelinan, M. M., Rudisill, M. E., & Sassi, J. (2020). Intervention strategies to elicit MVPA in preschoolers during outdoor play. *International Journal of Environmental Research and Public Health*, 17(2). <https://doi.org/10.3390/ijerph17020650>
- Wadsworth, D. D., Rudisill, M. E., Hastie, P. A., Irwin, J. M., & Rodriguez-Hernandez, M. G. (2017). Preschoolers' Physical Activity Participation Across a Yearlong Mastery-Motivational Climate Intervention. *Research Quarterly for Exercise and Sport*, 88(3), 339–345. <https://doi.org/10.1080/02701367.2017.1321099>
- Webster, E. K., Martin, C. K., & Staiano, A. E. (2019). Fundamental motor skills, screen-time, and physical activity in preschoolers. *Journal of Sport and Health Science*, 8(2), 114–121. <https://doi.org/10.1016/j.jshs.2018.11.006>

- Wiersma, R., Lu, C., Hartman, E., & Corpeleijn, E. (2019). Physical activity around the clock: Objectively measured activity patterns in young children of the GECKO Drenthe cohort. *BMC Public Health*, *19*(1), 1–11. <https://doi.org/10.1186/s12889-019-7926-3>
- Willis, E. A., Hales, D., Burney, R., Smith, F. T., Vaughn, A. E., & Ward, D. S. (2021). Providing Time in the Schedule Is Insufficient for Increasing Physical Activity in Childcare. *Translational Journal of the American College of Sports Medicine*, *6*(2), 1–9. <https://doi.org/10.1249/tjx.0000000000000156>
- Woodfield, L., Tatton, A., Myers, T., & Powell, E. (2022). Predictors of children’s physical activity in the early year’s foundation stage. *Journal of Early Childhood Research*, *20*(2), 199–213. <https://doi.org/10.1177/1476718X211052797>
- World Health Organization. (2019). Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age. World Health Organization. <https://apps.who.int/iris/handle/10665/311664>. License: CC BY-NC-SA 3.0 IGO
- Xu, H., Wen, L. M., Hardy, L. L., & Rissel, C. (2016). A 5-year longitudinal analysis of modifiable predictors for outdoor play and screen-time of 2- to 5-year-olds. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1), 96. <https://doi.org/10.1186/s12966-016-0422-6>
- Suzuki, Y. (2020). The Effect of Physical Play Experiences on Early Childhood Non-Cognitive Skills Development. *Journal of Education and Development*, *4*(3), 54.
- Zhang, Z., Kuzik, N., Adamo, K. B., Ogden, N., Goldfield, G. S., Okely, A. D., Crozier, M., Hunter, S., Predy, M., & Carson, V. (2021). Associations Between the Child Care Environment and Children’s In-Care Physical Activity and Sedentary Time. *Health Education and Behavior*, *48*(1), 42–53. <https://doi.org/10.1177/1090198120972689>
- Zhang, Z., Pereira, J. R., Sousa-Sá, E., Okely, A. D., Feng, X., & Santos, R. (2018). Environmental characteristics of early childhood education and care, daily movement behaviours and adiposity in toddlers: A multilevel mediation analysis from the GET-UP! Study. *Health and Place*, *54*(April), 236–243. <https://doi.org/10.1016/j.healthplace.2018.10.008>
- Zhang, Z., Sousa-Sá, E., Pereira, J. R., Okely, A. D., Feng, X., & Santos, R. (2019). The associations between environmental characteristics of early childhood education and care centres and 1-year change in toddlers’ physical activity and sedentary behaviour. *Journal of Physical Activity and Health*, *16*(11), 1000–1006. <https://doi.org/10.1123/jpah.2019-0066>