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Pre-school children's compliance with the WHO 24-hour movement behaviour guidelines: A systematic review of Sub-Saharan African studies

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Abstract

This review aimed to quantify the extent to which levels of habitual physical activity, sedentary behaviour, and sleep complied with WHO Guidelines in 3- to 4-year-olds in Sub-Saharan Africa. The systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). A literature search was conducted in August 2019 from PubMed, Web of Science, and Medline Ovid databases as well as grey literature. Eligible studies were assessed for quality using the Joanna Briggs Institute (JBI) tool for prevalence studies. Only three studies were eligible: two from one South African sample and one from Ghana which did not contain useable data. The South African studies reported high compliance with physical activity guidelines (n=87), with a mean total physical activity volume of 446 min/day (SD=67) and a median level of moderate-to-vigorous physical activity of 109 min/day (SD=37). Results further reflected a lower compliance with the screen time guidelines (n=56; mean screen time 2 h/day, SD=1.3), with no studies reported on sleep. There are insufficient data to draw meaningful conclusions on pre-school children's adherence to the 24-hour movement guidelines in Sub-Saharan Africa; thus warranting the need for future research in this region.

Keywords: Pre-school children, physical activity, sedentary behaviour, sleep, Sub-Saharan Africa.

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Introduction

Physical inactivity has been identified as one of the most important factors for global mortality and a contributor to the global rise in overweight and obesity. The number of overweight or obese infants and young children (age 0 to 5 years) increased from 32 million globally in 1990 to 40 million in 2016. This increase has been projected to reach 50 million by 2030 (World Obesity Federation, 2019).

In a global effort to counter the rise in overweight and obesity, the World Health Organisation (WHO) developed 24-hour movement behaviour guidelines for the early years. These guidelines comprise physical activity, sedentary behaviour, and sleep (WHO, 2019). The guidelines state that children aged 3-4.9 years should participate in 180 min of daily physical activity including 60 minutes of moderate-to-vigorous physical activity (MVPA). In addition, children should spend less than 1 hour behind a screen and less than 1 hour being restrained; and 10-13 hours of good quality sleep (WHO, 2019).

Several studies have found that among school-aged children and adolescents' levels of physical activity are lower than recommended (Aubert *et al.*, 2018; Reilly, 2015; Zhu *et al.*, 2019). Only a minority of children and adolescents globally meet the minimum recommendation of 60 minutes MVPA/day (Aubert *et al.*, 2018; Guthold *et al.*, 2018). However, there appears to be less global evidence on levels of physical activity in early childhood (Aubert *et al.*, 2018). This is because the concept of 24-hour movement behaviours is relatively new and the first global guidelines for these behaviours in young children were only published in 2019 (WHO, 2019). Therefore, it is unclear whether habitual levels of physical activity, sedentary behaviour, and sleep are adequate in children under 5 years of age globally. A few recent studies from high-income countries suggested that compliance to WHO 2019 guidelines might be low. These studies indicated that only a minority of children meet combined guidelines for physical activity, sleep, and sedentary behaviour (screen time) (Cliff *et al.*, 2017; De Craemer *et al.*, 2018; Lee *et al.*, 2017).

Childhood obesity may be a concern for public health in Sub-Saharan Africa because the childhood population is rapidly increasing and urbanising. Africa's childhood population is projected to reach 1 billion by 2025, which will make it the biggest childhood population compared to all the other continents (United Nations Children's Fund, 2019). A recent study has shown that excessive fatness was present in nearly a third of children across urban areas in Africa (Diouf *et al.*, 2018). This is consistent with the conclusions of another systematic review which linked urbanisation with a growing tendency of decreasing physical activity, increasing sedentary behaviours and decreasing fitness among children and adolescents in Africa (Muthuri *et al.*, 2014).

The study's primary aim, therefore, was to establish the available evidence on compliance with the 24-hour movement behaviour guidelines among 3- to 5-year-old children in Sub-Saharan Africa. A secondary aim was to identify gaps in the available evidence and develop future research questions.

Methodology

This systematic review was conducted and reported by following the Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines. PRISMA has

been defined as evidence-based guidelines with a minimal set of items for reporting systematic reviews and meta-analysis (Moher *et al.*, 2009). The protocol for the review was registered on PROSPERO on the 6th of August 2019 with Prospero registration number: CRD42019140909. The main search terms were developed following the PECO (population, exposure, comparator, outcome) format, but only population (Preschool children of 3.0 to 4.9 years in Sub-Saharan Africa), and exposure (time spent in physical activity, while sleeping and being sedentary, including screen time) were included.

Study inclusion and exclusion criteria

In this review, the following studies were included: studies which included healthy, typically developing, children aged 3.0 to 4.9 years residing in Sub-Saharan Africa and reported on objectively or subjectively measured habitual time spent in physical activity, or while sleeping or during sedentary engagements, including screen time. Only articles published in English language were considered. All the articles, which fulfilled the above inclusion criteria, were examined regardless of the years when published. Articles were excluded if they were non-English language publications, if participating children were less than 3.0 years and older than 4.9 years, reported studies with children who had a physical or learning disability, or who were unhealthy.

Literature search

Three databases (Medline Ovid, PubMed, and Web of Science) were searched in August 2019. The searches were independently performed by two researchers, one of whom was a specialist librarian, using the following search terms: population (preschool, child) and exposure (time spent in physical activities, sleeping and time spent in sedentary behaviours including screen time); the search terms were used in separation or in combination using the boolean operator like "OR" and "AND". The literature search was restricted to Sub-Sahara Africa. An example of a search strategy from Web of Science is attached as an appendix (Appendix 1), which was subsequently adapted for the other two databases. References were exported, de-duplicated and reviewed using Endnote X9. Two researchers independently assessed the titles/abstracts (JN and XJ) and full-text articles were obtained for those papers which met the inclusion criteria. Full-text articles were screened (JN and XJ) and the two researchers resolved differences in opinion over the eligibility of papers to be included by discussion, referring to a third author (JR) where necessary.

Grey literature searching

Grey literature was searched through each country's domain website (e.g. Ghana – com.gh and South Africa – com.za), whereby in the advanced google search box the following words were entered: Physical activity OR sedentary behaviour OR Screen OR Sleep AND preschool children, then searched.

Data extraction, quality assessment and synthesis

Two researchers independently used the adapted pre-specified excel data sheet to extract all the necessary data from eligible studies (JN and XJ). The necessary data extracted from the studies included the following: study location, design, exposure type (physical activity, sedentary behaviour, and/or sleep), exposure description, exposure measurement type, age and sex of sample, and summary measures of time spent in the behaviours. Any minor disagreements between the two researchers over data extracted were resolved through discussion. The data-extracted excel sheet is provided in Appendix 2.

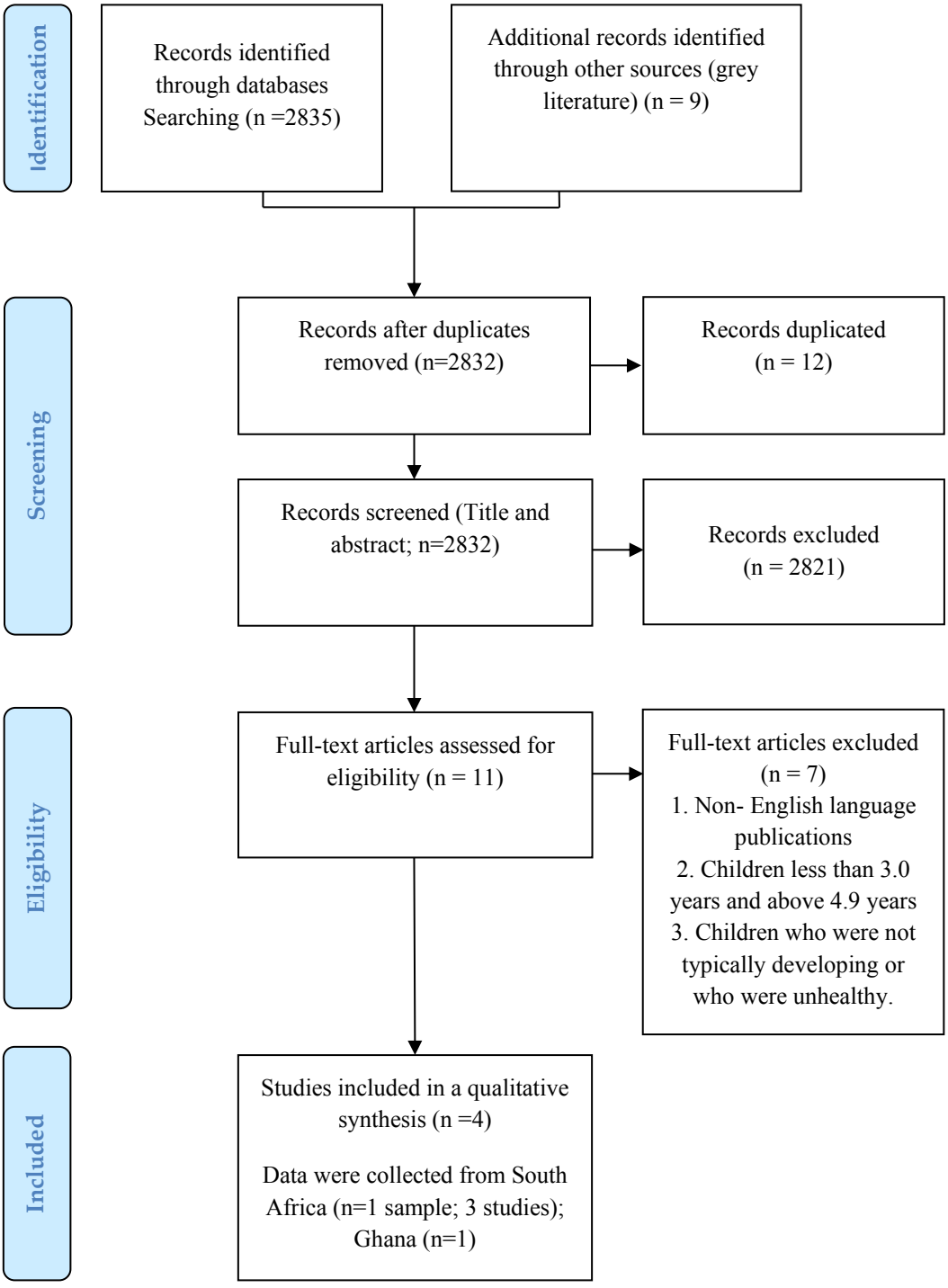
To test for compliance with recommendations in relation to 24-hour movement behaviours, we used the WHO 2019 guidelines for 3.0 to 4.9-year olds stating that children should, in a 24-hour period: 1) spend at least 180 minutes in physical activity, of which at least 60 minutes should in MVPA; 2) Spend 10.0-13.0 hours asleep; 3) Spend no more than 1 hour per day using a screen. Authors of the present study contacted the corresponding author of one of the eligible studies (Draper *et al.*, 2017) for clarification of data presented in that study and the corresponding author graciously provided the information which was subsequently used in the analysis. Two researchers (JN and JR) independently used the Joanna Briggs Institute (JBI) checklist of the quality of prevalence studies and assessed the quality of individual studies (risk of bias) which were included in this review (The Joanna Briggs Institute, 2009). Minor differences between the two researchers were resolved by discussion.

Results

Eligible studies and study selection process

A total of 2835 and 9 records were found via the database and grey literature searches, respectively. After de-duplication, 2832 papers were screened for inclusion. Subsequent to assessing the title and abstract, 2821 were removed from the record as they did not meet the inclusion criteria. Therefore, 11 articles remained which were considered for full-text screening. Finally, four studies using two unique samples were considered to be eligible and included in this systematic review (2019; Draper *et al.*, Draper *et al.*, 2017; Okyere, 2018; Tomaz, 2018). Of these four studies, one was conducted in Ghana (Okyere, 2018) and the other three in South Africa (Draper *et al.*, 2019; Draper *et al.*, 2017; Tomaz, 2018). A schematic overview of the steps used in the systematic review process is illustrated in the PRISMA flow diagram presented in Figure 1. The South African studies were reported in one PhD thesis (Tomaz, 2018) and two published studies (Draper *et al.*, 2019; Draper *et al.*, 2017). The three studies addressed different research questions and had slightly different sample sizes - for the present synthesis of review findings we selected the published study with the largest sample size of 3.0-4.9y olds for physical activity (Draper *et al.*, 2017), and the only publication which reported screen time (Tomaz, 2018).

Figure 1: Prisma flow diagram.



A narrative synthesis of the studies

Table 1 summarises the three eligible studies published based on two unique samples. Neither study reported the levels of compliance with recommendations in relation to all the three behaviours (physical activity, screen time, and sleep), though the South African study reported the compliance levels for total volume of physical activity and screen time (Draper *et al.*, 2019; Draper *et al.*, 2017; Tomaz, 2018). The South African study used convenience sampling in urban and rural areas and obtained data on the following behaviours: habitual levels of physical activity, sedentary behaviour, and sleep. The study from Ghana measured habitual levels of physical activity in pre-school children from a single urban municipality, but used the parent-reported Global Physical Activity Questionnaire (GPAQ) to measure levels of physical activity which is intended for adults, not children (Okyere, 2018).

Table 1: Summary of eligible studies.

Author/ years	Sample size/Age (n)	Data Collection (years)	How behaviours were measured	Levels of movement behaviours	Comments
Okyere (2018)	N: 201 Age: 3-5-year-olds	2018	Children's physical activity levels using the GPAQ (parent-reported)	54.2% of the sample reported to do at least 30 min/day MVPA 3-5 times/week	Levels of physical activity and compliance with guidelines unclear
Draper et al. (2017)	N: 87 Age: 3-4 year-olds	2012-2014	Physical activity and sedentary behaviour measured by Actigraph GT3X accelerometer	90.8% of the sample complied with the physical activity recommendation; Mean total daily physical activity 446.4 min/day (SD 67.6) Median daily MVPA 109.3 min/day (SD 36.5)	The same sample as Tomaz et al. (2018); Samples were taken from rural and urban areas
Tomaz (2018)	N: 56 (screen time) Age: 3-4 year-olds	2012-2014	Screen-time by parent questionnaire	Mean screen time (n 56) 2.0 hr/day (SD 1.3)	The same sample as Draper et al. (2017); sample were taken from rural and urban areas

Study quality appraisal

The study quality appraisal is summarised in Table 2. The eligible studies generally did not set out with nationally representative prevalence estimates as their primary aims and consequently did not meet some of the quality criteria in the JBI checklist. Eligible study samples were not randomly selected or nationally representative (Draper *et al.*, 2019; Draper *et al.*, 2017; Okyere, 2018; Tomaz, 2018).

Table 2: Quality appraisal summary using the Joanna Briggs Institute, (JBI) tool (The Joanna Briggs Institute, 2009).

Criteria	Okyere (2018)	Draper et al. (2017)	Tomaz et al. (2018)
Sample frame appropriate	NO	YES	YES
Participants sampled appropriately	YES	NO	NO
Is the sample size adequate?	YES for estimating prevalence in the target population only	YES for purposes of an original study, not as prevalence estimate	YES for purposes of an original study, not as prevalence estimate
Subjects & settings described in detail?	YES	NO, but in subsequent publications	NO, but in subsequent publications
Data analysis conducted with sufficient coverage?	NO	YES	YES
Valid methods used for the identification of all the behaviours	NO	NO, not for all behaviours	NO, not for all behaviours
Standard, reliable method of measuring the behaviours in all participants	NO	YES	YES
Appropriate statistical analysis	NO, not for a prevalence estimate	NO, not for a prevalence estimate	NO, not for a prevalence estimate
Response rate adequate/dealt with	NO	YES	YES

Discussion

The main aim of this systematic review was to quantify the compliance with the recently published WHO guidelines (April 2019) on habitual levels of the 24-hour movement behaviours (physical activity, screen time, sleep time) in preschool children in Sub-Saharan Africa. The results of the systematic review showed that data on compliance with 24-hour movement behaviours in Sub-Saharan Africa was very limited, even with relatively broad inclusion criteria which comprised both subjective and objective measures of the behaviours. No studies examined all three 24-hour movement behaviours combined and evidence on adherence to the

individual components of the guidelines was also limited. Only four studies were eligible for inclusion in this systematic review (Draper *et al.*, 2019; Draper *et al.*, 2017; Okyere, 2018; Tomaz, 2018), using two unique samples, and one study could not be used with confidence as the tool used to measure levels of physical activity (GPAQ) were intended for adults, not children. Childhood obesity in general, and the 24-hour movement behaviours in particular, may not have been a high priority for public health research and surveillance in Africa in the past. The burden of undernutrition and infectious disease, as well as the lack of capacity in, and focus on, childhood obesity may explain the paucity of evidence identified in the present review.

Due to the very limited evidence available for inclusion in this review, results cannot be compared between countries in Sub-Saharan Africa. However, several studies have been carried out in high-income countries (HICs) which can be used for comparison. In a study of 151 Canadian children, the majority of toddlers (age: 19.0 months; SD=1.9 months) met the individual physical activity (99.3%; n=141) and sleep (82.1%, n=124) recommendations, while only 23 toddlers met the screen time recommendation (15.2%) (Lee *et al.*, 2017). Similarly, another study in Canada involving 803 children (mean age: 3.5 years; 95% CI = 3.5, 3.6), showed a high proportion of children meeting physical activity (61.8%) and sleep (83.9%) recommendations, but few met the screen time recommendation (24.4 %), while 3.3% did not meet any of the three recommendations (Chaput *et al.*, 2017). Only 12.7% met all three recommendations contained in the guidelines. Results of an Australian study of 248 preschool children (mean age 4.2 years ± 0.6 years) showed similar results, with a high proportion of the children meeting physical activity (93.1%) and sleep (88.7%) guidelines, but fewer children complying with the screen time guideline (17.3%), and only 14.9% fulfilling all the three recommendations (Cliff *et al.*, 2017). The GET UP! - A study conducted in Australia, found that of the 202 toddlers studied (mean age: 19.7 ± 4.1 months), only 8.9% met the overall 24-hour movement recommendations, high percentages met physical activity (96.5%) and sleep (79.7%) recommendations, but only 11.4% were compliant with the screen time recommendations (Santos *et al.*, 2017). A recent Belgian study of 1082 pre-schoolers (mean age: 4.2years; SD = 0.02years), of whom 595 had data for all the variables, found that only 10% complied with all WHO recommendations on weekdays and 4% on weekends and that compliance with physical activity guidelines among the Belgian pre-schoolers was low (De Craemer *et al.*, 2018).

In summary, recent studies of compliance with the 24-hour movement behaviour guidelines among Canadian and Australian pre-schoolers found that a high proportion of the children complied with the physical activity and sleep recommendations, but there was very low compliance with meeting all the three recommendations; which suggests that screen time was not well complied with. In contrast, a study of pre-schoolers in Singapore noted that the percentage of children who failed to meet the sleep recommendations was particularly high

(Chen *et al.*, 2019). It is possible that there is a common trend in HICs, but cultural differences and disparity between studies in the accelerometry cut-offs used to measure total volume of physical activity and MVPA might play a part in explaining the discrepant findings between studies. Future research will be needed to determine whether discrepancies between studies in level of compliance with WHO guidelines are due to methodological differences or attributable to real differences between populations (e.g. cultural or environmental differences).

The South African study included in this review showed high levels of physical activity with 91% of the sample meeting the guideline for total daily physical activity, but mean levels of daily screen time were well above the guideline, and no sleep time data were available. There may be differences in the socio-economic and cultural environment between studies, which complicate data interpretation. A large cohort study in Brazil, a middle-income country, suggests that pre-school children (birth-4years) from higher-income earning families go to bed and wake up later than children of lower-income families (Netsi *et al.*, 2017). On average though, the times of going to bed and waking up are shifted by around two hours later in low and middle-income countries (LMIC's) compared to families from HIC's (Netsi *et al.,* 2017). However, it was also noted that families with lower income and maternal education tended to have higher rates of co-sleeping (Netsi *et al.*, 2017). A study (Chaput *et al.*, 2015), suggests that there is a possibility that in HICs, children's days are more structured and regulated while in LMICs there is more flexibility and discretionary time, which might mean that children from LMICs have less sleep than those from HICs.

The present review and the research evidence upon which it was based had several strengths and limitations that are worth mentioning. The main strengths were the novelty and timeliness of the review as well as the importance of the research questions. In addition, the review was conducted and reported rigorously, following PRISMA guidances and a grey literature search. The limitations were; first, the number of eligible studies was sparse, thus limiting the ability to make meaningful conclusions about levels of the 24-hour movement behaviour in preschool children in Sub-Saharan Africa. The main finding of the present review, which is considered strikingly timely, is that there is a need for more research on the subject, especially timely since the WHO (2019) guidelines highlight the importance of the time spent in the behaviours to individual child health and wellbeing, and to population efforts to tackle obesity and related non-communicable diseases. Second, the quality of studies included in the systematic review was somewhat limited, but they did not set out to measure compliance with all of the 24-hour movement behaviour guidelines as their primary aim. There is a need for research with this specific aim in future, and an international effort to improve surveillance of the 24-hour movement behaviours among pre-school children at an early stage (Sunrise Study, 2020). Finally, the searches from the database and grey literature were limited to research published in English language, excluding non-English studies. Therefore, it is plausible that studies

published in other languages which might have partly met the search criteria, were they written in English, have been excluded.

Conclusions

Few studies have examined the levels of or compliance with 24-hour movement behaviours in pre-school children in Sub-Saharan Africa to date, and the dearth of data from Africa in general is a concern. Future research on levels of the 24-hour movement behaviours among young children in Sub-Saharan Africa should be conducted. Such studies should consider the principles and practice of obtaining prevalence estimates with confidence, utilise valid methods, and consider the possible influence of urban versus rural settings, and socioeconomic status on compliance with WHO guidelines.

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Appendix 1: An example of a search strategy from Web of Science and it was adapted for the other two databases.

1 *Child, Pre-schooler/
2 *Sleep/
3 *Bed Rest/
4 2 or 3
5 Physical activity.mp.
6 Active play.mp.
7 *Physical Exertion/
8 *running/ or *swimming/ or *walking/
9 5 or 6 or 7 or 8
10 *Sedentary Behavior/
11 sedentary lifestyle.mp.
12 "Physical Inactivity".mp.
13 *Restraint, Physical/
14 10 or 11 or 12 or 13
15 screen time/
16 *Video Games/
17 *television/ or *videodisc recording/ or *videotape recording/
18 computer.mp.
19 "Play Station".mp.
20 DVD*.mp.
21 "electronic gam*".mp.
22 *Smartphone/
23 Ipad*.mp.
24 Laptop*.mp.
25 15 or 16 or 17 or 18 or 19 or 20 or 21 or 23 or 24
26 Afric*.mp.
27 Sub-sahara.mp.
28 26 or 27
29 4 or 9 or 14 or 25
30 1 and 28 and 29

Appendix 2: Data extraction table

Author/ year	Study Design	Sample (N)	Sample Age (mean);	Behaviour	Exposure Description	Exposure Measurement Type	Measurement Description	Units	Baseline Mean	Baseline SD	NOTES
Draper et al. 2017	Cross-section	N=87	Age 3-4 years; mean age 4.5 y	Physical activity	LPA	Actigraph GT3X+ accelerometers	Actigraph 25-420 counts/15s, 20 minutes consecutive zeros, 24h/day, 7 days, 15s epochs	Min/day	337.1	46.8	Emailed author for data 3-4-year-olds
Draper et al. 2017	Cross-section	N=87	Age 3-4 years; mean age 4.5 y	Physical activity	MPA	Actigraph GT3X+ accelerometers	Not reported	Min/day	83.3	24.4	Emailed author for data 3-4 year olds
Draper et al. 2017	Cross-section	N=87	Age 3-4 years; mean age 4.5 y	Physical activity	VPA	Actigraph GT3X+ accelerometers	Not reported	Min/day	25.9	14	Emailed author for data 3-4 year olds
Draper et al. 2017	Cross-section	N=87	Age 3-4 years; mean age 4.5 y	Physical activity	MVPA	Actigraph GT3X+ accelerometers	Actigraph > 420 counts/15s, 20 minutes consecutive zeros, 24h/day, 7 days, 15s epochs	Min/day	109.3	36.5	Emailed author for data 3-4 year olds
Draper et al. 2017	Cross-section	N=87	Age 3-4 years; mean age 4.5 y	Physical activity	LMVPA	Actigraph GT3X+ accelerometers	Actigraph> 25 counts/15s, 20 minutes consecutive zeros, 24h/day, 7 days, 15s epochs	Min/day	446.4	67.6	Emailed author for data 3-4 year olds
Draper et al. 2017	Cross-section	N=87	Age 3-4 years; mean age 4.5 y	Physical activity	LMVPA	Actigraph GT3X+ accelerometers	Actigraph> 25 counts/15s, 20 minutes consecutive zeros, 24h/day, 7 days, 15s epochs	% meeting 180min/day guidelines	100% weekly average; 98.2% daily		Emailed author for data 3-4 year olds
Senyo 2018	Cross-section	N=201	Range 2-5 years; mean age 3.9 y	Physical activity	MPA	WHO Global Physical Activity Questionnaire	Categorical at least 30min MVPA per day	%	Not at all: 7.5%; 1-2 times 38.3%; 3-5		MPH thesis

									times 17.4%; all week 36.8% Not at all: 11.9%; 1-2 times 39.8%; 3-5 times		
Senyo 2018	Cross-section	N=201	Range 2-5 years; mean age 3.9 y	Physical activity	VPA	WHO Global Physical Activity Questionnaire	Categorical at least 60 min VPA per day	%	24.9%; all week 23.4%		MPH thesis
Tomaz 2018	Cross-section	N=56	Age 3-4 years	Screen time	Screen time	Parent questionnaire	Not validated questionnaire	hr/day	2	1.3	PhD thesis
Draper et al. 2019	Cross-section	Same sample as Draper et al., 2017									

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