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The Impact of COVID-19 Pandemic on Movement Behaviors of Children Under the Age of Five, A Narrative Review

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Abstract

Background: In March 2020, WHO declared COVID-19 a global pandemic. Since then, our lives have changed significantly, particularly vulnerable groups, such as young children. A young child's movements throughout a typical day include sleeping, sitting, and physical activity (PA) of different intensities. In 2019 the WHO released the first global guideline for movement behavior of children under the age of five. Due to the distinct movement behavior recommendations for this age group and the impact of the COVID-19 pandemic on these behaviors, the present review aims to appraise the literature from across the globe on the effect of COVID-19 on movement behaviors, including screen-time, PA, and sleep in infants, toddlers, and preschoolers.

Methods: PubMed and Google scholar electronic database were searched, the titles and abstracts of all articles retrieved from the search were screened and duplicates were removed. The full texts of potential articles to be included in the study were then reviewed based on the inclusion criteria, and data were extracted from the selected studies using a Microsoft Excel sheet.

Results: This review included 11 studies. Four studies cross-sectional, six longitudinal, and one cohort study. The sample size ranged from 25 to 4,136 children. In all of the studies, the sedentary screen-time increased significantly. Sleep, on the other hand, did not change significantly in the majority of the studies, although sleep duration increased in some studies. There were large discrepancies between the device-measured and parent-reported outcomes regarding physical activity that decreased in all studies, except for the Hong Kong and Sweden studies it increased.

Conclusion: As the world is still recovering from the impact of the COVID-19 pandemic and managing the uncertainty of other pandemics that may occur, our review can help to promote a healthy balanced pattern of movement behaviors by providing information to support parents of young children.

Keywords: Toddlers/Preschoolers, COVID-19, Movement Behaviors, Screen-Time, Physical Activity, and Sleep.

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1. Introduction

Coronavirus disease (COVID-19) first emerged in late 2019, and in March 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic. Since then, our lives have changed significantly. Nations worldwide have responded in different ways, including nationwide lockdowns, school closures, social distancing, and mandatory mask-wearing, to handle the crisis. This has had a psychological impact on various populations, particularly vulnerable groups, such as children and the elderly (Douglas & Programme Co-Director, n.d.).

Early childhood (<5 years old) is a period of rapid physical and cognitive development, during which most children's physical, behavioral, language, social, and motor development occurs. The early years are critical for children to receive nurturing care. This is also the period when children are most sensitive to interventions (The Lancet, 2016). A young child's movements throughout a typical day include sleeping, sitting, and physical activity (PA) of different intensities. An appropriate balance between these movement behaviours is vital for the child's physical and mental development. The amount of time spent on one movement behavior results in a decrease in another; for example, increasing screen time may decrease physical activity and/or sleep. Therefore, there is a need for an integrated approach to assess all three movement behaviors together (Nyström et al., 2020).

In 2019, the WHO released the first global guidelines for movement behavior of children under the age of five. The guidelines recommend that during a 24-h day, preschool children (aged 3–4 years) should accumulate at least 180 min of PA, of which at least 60 min should be of moderate to vigorous intensity (MVPA), engage in no more than one hour sedentary screen-time (e.g., television viewing, using a computer or tablets/smartphones while sitting) (SST), and have 10–13 h good-quality sleep per day (WHO, 2019). With these newly developed integrated movement guidelines, it is necessary to assess the proportion of children worldwide who adhere to these guidelines. Accordingly, the International Study of Movement Behaviors in the Early Years (SUNRISE) was initiated and includes countries with varying economic statuses. Pilot work for this study began in 2018 ("SUNRISE", 2022).

Nowadays, young children and infants have more devices readily available for their use and are exposed to more technology at an earlier age than that in previous decades. In 2016, the American Academy of Pediatrics recommended avoiding screen-time for children younger than two years and limiting screen use to one hour per day for children aged two to five (Hill et al., 2016). A meta-analysis of 63 studies on the prevalence of screen-time among children aged five and younger showed that for children younger than two years, the prevalence of meeting the screen-time guideline was 24.7% (95% CI, range:19.0%-31.5%). For children aged two to five years, the mean prevalence of meeting the screen-

time guideline was 35.6% (95% CI, range: 30.6%-40.9%) (McArthur et al., 2022).

However, when preschools were closed and children were forced to stay at home during the peak of the restrictions in the wake of the COVID-19 pandemic, the screen-time of most children increased markedly (Wong, 2021). During quarantine, in the absence of social support, mothers may also have turned to digital media more often to occupy the role of babysitters (Pedrotti et al., 2022). Population-based studies have suggested a negative association between excessive screen-time in early childhood and language development. Conversely, a recent meta-analysis found that while increased screen-time was associated with lower language skills, quality screen-time (educational programs) and caregiver scaffolding during screen-time were associated with stronger language skills in children under 12 years of age (Bergmann et al., 2022). Still, there are concerns regarding media use during routine activities, especially at mealtimes and at bedtime, related to adverse outcomes in children, such as obesity and decreased sleep duration and quality (Pedrotti et al., 2022).

The sleep problem is another negative outcome related to increased screen-use and sedentary behavior. Blue light exposure in the evening suppresses melatonin production, which affects sleep initiation and reduces sleep duration (Wong, 2021). A meta-analysis of 31 studies on the association between screen-time, sedentary time, and PA with sleep in children under five years of age revealed that increased screen-time is associated with poorer sleep outcomes in infants, toddlers, and preschoolers. In addition, PA and outdoor play were positively associated with most sleep outcomes in toddlers and preschoolers (Janssen et al., 2020).

Aims of the review:

To our knowledge, to date, no systematic review has examined the impact of COVID-19 on movement behaviors, including screen-time, PA, and sleep, in children less than five years old. Since there are distinct movement behavior recommendations for young children, the present review aims to combine the literature from across the globe on the impact of COVID-19 on movement behaviors, including screen time, physical activity, and sleep in infants, toddlers, and preschoolers.

Studies were included if they met all of the following criteria:1) reported results from cross-sectional, longitudinal, or cohort studies; 2) assessed the impact of COVID-19 on movement behaviors, including screen-time, PA, and sleep in infants, toddlers, and preschoolers; 3) were written in English.

The exclusion criteria were as follows: 1) clinical populations (e.g., children with chronic health conditions, e.g., diabetes, or developmental disorders, such as autism); 2) qualitative studies; 3) studies assessing anxiety among parents or caregivers during the COVID-19 pandemic; 4) studies focusing on individual movement behavior while excluding others; 5) studies written in languages other than English.

2. Material and Methods

The PubMed and Google scholar electronic database was searched using a strategy that combined Medical Subject Headings (MeSH) terms and free-text terms related to toddlers/preschoolers, COVID-19, movement behaviors, screen-time, PA, or sleep. The titles and abstracts of all articles retrieved from the search were screened and duplicates were removed. The full texts of potential articles to be included in the study were then reviewed based on the inclusion criteria. Data were extracted from the selected studies using a Microsoft Excel sheet and included the following information: study title, study design, year, location, study participants, measurement tools, and main results.

3. Results

This review included 11 studies that discussed the impact of the COVID-19 pandemic on movement behaviors in children less than five years old. Four studies were cross-sectional, six were longitudinal (before and during the pandemic), and one was a cohort study. They were from different parts of the world, including North and South America, Europe, and South and East Asia, but no Arab or African country, except Morocco. The most studied age group was 3–5-year-olds., two articles were on 1-5-year-olds, one study focused only on 4-year-olds, and another focused on 4-6-year-olds. The sample size ranged from 25 to 4,136 children. All the studies were based on parent-reported questionnaires, except for five studies that also included objective measures using accelerometers.

Table (1) Characteristics and Significant findings of included studies

	Author, year	Study design	Location	Participants	Tools of measurement	Main results
1	(Jáuregui et al., 2021)	Cross-sectional study	Mexico	631 caretakers and parents responsible for children aged 1-5	An adapted version of the SUNRISE study questionnaire The WHO guidelines for children under five years of age	Physical activity decreased by 25% than that before the pandemic (234.3 vs 174.0 min/d) Screen-time doubled (97.5 vs 192.8 min/day) Sleep time decreased by 2% (13.8 vs 13.6 h/d) The percentage of children who met the recommendations were as follows: • TPA (61.1% vs 36.2%) • ST (15.7% vs 3.6%) The three recommendations altogether (5.7% vs 1.3%) ($p<0.05$)
2	(Okely et al., 2021)	Longitudinal study (before and after the pandemic)	14 countries (Australia, Bangladesh, China, Hong Kong, India, Indonesia, Malaysia, Morocco, Pakistan, Spain, Sri Lanka, Sweden, United States, Vietnam.)	948 parents of children aged≥3.0 years and≤5.11 years	An adapted version of the SUNRISE study questionnaire The WHO guidelines for children under five years of age	Children had 55 min/day more screen-time than earlier ($p<0.0001$) (105.3 vs 162 min/d) No significant change in physical activity and total sleep duration The percentage of children who met the recommendations were as follows: The proportion who met the SST guideline dropped from 48% to 25% ($p<0.0001$). No significant changes were observed in other behavioral variables.
3	(Aguilar-Farias et al., 2021)	Cross-sectional study	Chile	3157 Caregivers of 1-5-year-old children	An adapted version of the SUNRISE study questionnaire	Mean time spent in physical activity decreased (3.6 vs 2.82 h/d) Screen-time and sleep duration increased (1.66 vs 3.05 h/d) and (10.92 vs 11.01 h/d) respectively. Sleep quality (score 1-7) significantly decreased (5.68 vs 4.93)
4	(Brzęk et al., 2021)	Cohort Study	Poland	1361 children aged 3-5	Questionnaire consisting of 62 questions, according to the recommendations of Health Behavior in School-aged Children (HBSC)	Sedentary position increased (2 vs 3 h/d) during the COVID-19 pandemic. Analyzing all devices combined, 62.83% of three-year-olds, 66.67% of four-year-olds, and 85.49 of five-year-olds showed an increase in screen-time. On an average, children slept for 9.74 h (SD, 1.18) before the pandemic and 10.11 h (SD, 1.21) during the pandemic
5	(Y Ng et al., 2021)	Longitudinal study	Hong King	25 children aged four	Physical activity was measured using	Accelerometer: • Sedentary behavior decreased by 9% (663 vs 601 min/d) • Time spent sleeping increased by 8% (580 vs 627)

					ActiGraph wGT3X-BT accelerometers Parent-reported questionnaires	• Time spent in MVPA increased by 16% (90 vs 105) Questionnaire: • Parent-reported sedentary screen-time increased (78 vs 147 min/d) • Parent-reported MVPA decreased (36 vs 23).
6	(Alonso-Martínez et al., 2021)	Longitudinal study	Spain	145 preschoolers aged 4 to 6 (Device-measured physical activity for 21 children)	GENEActiv tri-axial accelerometer Child self-regulation and behavior questionnaire (CSBQ)	Device-measured: • Preschoolers showed a decrease in total physical activity (346.9 vs 303.6 min/d) and MVPA (91.6 vs 74.6 min/d) • Increase in Sedentary time (609.6 vs 659.8 min/d) • No significant change in sleep duration.
7	(Kracht et al., 2021)	Cross-sectional study	United states	1836 Mothers of children between the ages of 3.0–5.9 years	Survey used was specifically developed for this study	Most mothers reported that their preschooler was less physically active (38.9%) Same amount of time spent sleeping (52.1%) Increased screen-time (74.0%) after the COVID-19 outbreak.
8	(Nyström et al., 2020)	Longitudinal study	Sweden	100 children (58 boys and 42 girls) aged 3-5	ActiGraph wGT3x-BT tri-axial accelerometer. Parent-reported questionnaire	Physical activity increased (209 vs 262 min/d) Screen-time increased (106 vs 136 min/d). The proportion of children who met the components of the WHO guidelines=19.4% Screen-time, physical activity, and sleep guidelines were met by 37.8% (n=37), 90.3% (n=65), and 62.5% (n=45) of the children, respectively.
9	(Hyunshik et al., 2021)	Longitudinal study	Japan	Children aged 3–5 (n =504)	A tri-axial accelerometer was used. Parent-reported questionnaire	MVPA significantly decreased from 93 min to 88 min. PA decreased slightly (479 min to 450 min) Sedentary time increased (164 min to 174 min) Sleep duration increased, but not significantly (619.1 min to 623.8 min); p=0.145 Meeting the WHO guideline: • All components decreased, but not significantly (15.6% vs 13.4%); p=0.323. • Physical activity decreased, but not significantly (84.7% vs 82.4%); p=0.593 • Screen-time decreased significantly (27.2% vs 19.9%) p=0.010.

						• Sleep duration decreased, but not significantly (83.7% vs 79.2%); p=0.437
10	(Hossain et al., 2021)	Longitudinal study	Bangladesh	65 children aged between 3 years and 5 years	Two types of accelerometers were used: ActiGraph wGT3x-BT was worn over the right hip and the activPAL 4 was attached to the right thigh Parent-reported questionnaire	TPA decreased significantly (270.3 vs 77.3 min/d) MVPA decreased significantly (83.7 vs 25.4 min/d) Screen-time increased significantly (192.2 vs 277.0 min/d) Sleep duration did not change significantly (605.5 vs 593.0 min/d); p=0.33. Meeting the WHO Guideline: • Physical activity (42.1%) • Screen-time (17.5%) • Sleep (59.7)
11	(Jauregui et al., n.d.)	Cross-sectional study	Chile, Mexico, and the USA	4,136 main caregivers of 1- to 5-year-old children	Parent-reported questionnaire	PA decreased significantly (214.7 vs 169.4 min/d in Chile), (230.9 vs 174.3 min/d in Mexico) and (203.8 vs 164.3 min/d in US Latinos) Screen-time increased significantly (99.1 vs 182.9 min/d in Chile), (98.2 vs 190.0 min/d in Mexico) and (107.5 vs 196.0 min/d in US Latinos) Sleep duration did not change significantly Meeting WHO Guideline: • Physical activity (34.0-37.5%) • Screen time (<10%) • Sleep (no change)

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4. Discussion

This review article summarizes evidence on the effect of COVID-19 on movement behaviors in children under the age of five, including screen-time, PA, and sleep. In all of the studies, the sedentary screen-time increased significantly. Sleep, on the other hand, did not change significantly in the majority of the studies, although sleep duration increased in some studies (Aguilar-Farias et al., 2021; Brzęk et al., 2021; Y Ng et al., 2021). This appeared to be due to later bedtimes and wake-up times as a result of changes in their usual daily habits.

Furthermore, there were large discrepancies between the device-measured and parent-reported outcomes regarding changes in children's movement behavior. PA decreased in all studies, except for the Hong Kong and Sweden studies (Nyström et al., 2020; Y Ng et al., 2021). Parents reported a decrease in their children's total PA, but the device-measured outcomes did not support these claims. This could be explained by the fact that self-reported measures over-estimate PA and are less precise than device-based measures (e.g., accelerometers). The possibility of social desirability bias may also have an influence on the caretakers' responses. Preschools, playgrounds, and parks remained open in Sweden during the COVID-19 pandemic, in contrast to many other countries, and the responsibility for social distancing was placed on the Swedes themselves (or upon the parents of young children). Furthermore, preschools changed their routines to have children outside for as long as possible. Thus, an increase in the children's PA during the COVID-19 pandemic was observed in this study (Nyström et al., 2020). On the other hand, in Hong Kong, although preschools were closed and children spent more time at home, they were more active. One might infer that compared with being at home, the children's PA might be more compromised in school, which could be a result of the extended time students spend sitting (i.e., SB) when receiving instructions in preschools in Hong Kong (Y Ng et al., 2021).

The strengths of this study include a large sample size and the inclusion of studies from across over the world, encompassing high- and low-to-middle-income countries. However, no studies from the Middle East or Africa (except Morocco) were included. As most of the studies were conducted online, voluntary response bias may have influenced the sample composition. Participants were more concerned about their children's health and were more likely to notice impairments in their children's movement behaviors. Furthermore, since convenience sampling was used, these findings cannot be extrapolated beyond the study participants. Another limitation of some studies was that movement behaviors were reported by parents rather than being objectively measured. This could be due to COVID-19 restrictions, as the use of accelerometers was not permitted because of the mandate of physical distancing. The use of self-reported measures in these studies may also have skewed the results (e.g., social desirability and

recall). Finally, as the studies were cross-sectional, causality could not be inferred.

This study offers several implications for future research. Firstly, larger studies with representative sample sizes are required to confirm or contrast with these findings. Secondly, our findings indicate that a large proportion of young children are exposed to excessive screen-times. Therefore, future research should examine the underlying causes and methods for reducing screen-time in this age group. Creating resources that suggest ways to incorporate both indoor and outdoor physical activity, reduce SST, and promote healthy levels of sleep during times of movement restriction could be particularly beneficial for both parents and children. The findings of our study emphasize that movement behaviors are intrinsically linked. A systematic review published in 2017 found that interventions that combined the three movement behaviors (e.g., increasing PA, limiting ST, and promoting adequate sleep time) had more beneficial effects than those that targeted the behaviors separately (Kuzik et al., n.d.). Therefore, a comprehensive strategy to encourage compliance with the recommendations of all three behaviors is required.

In conclusion, as the world is still recovering from the impact of the COVID-19 pandemic and managing the uncertainty of other pandemics that may occur, our review can help to promote a healthy balanced pattern of movement behaviors by providing information to support parents of young children.

5. Declarations

5.1 Conflict of Interest Statement

The author has no conflict of interests to declare.

5.2 Funding Disclosure

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