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Adherence to the WHO physical activity, screen time and sleep guidelines and associations with socio-demographic factors among Ethiopian preschool children: The SUNRISE study

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Abstract

Background The World Health Organisation (WHO) has called for more evidence on 24-hour movement behaviours from low- and middle-income countries. We examined the proportion of Ethiopian children aged 3.0-4.9 years who met the WHO guidelines on physical activity, screen time and sleep for children under the age of five, and the associations between meeting the guidelines and socio-demographic factors.

Methods A cross-sectional study was conducted in Adama and Lume district, Ethiopia. Children were recruited through kindergartens in Adama city and rural villages of Lume district, Ethiopia. Physical activity and sleep were measured using ActiGraph accelerometer. Screen time and restrained sitting were parent-reported. Multivariable logistic regression models tested associations between meeting the individual and combined WHO guidelines and socio-demographic factors.

Results A total of 430 children participated in the study (mean age 4.2 ± 0.6 years). More than half the children (58.0%) met all the WHO guidelines. A higher proportion met the physical activity (96.1%) and sleep guidelines (91.9%) compared to the screen time guideline (63.5%). Children who lived in rural areas were more likely to meet the screen time (84.6% vs. 38.2%, AOR = 7.31; 95%CI: 3.93, 14.02), sleep (98.6% vs. 83.8%, AOR = 8.60; 95%CI: 3.55, 23.73) and combined (81.3% vs. 30.1%, AOR = 7.41; 95%CI: 4.04, 13.97) guidelines than those who lived in urban areas.

Conclusions Children from rural Ethiopia were more compliant with the WHO guidelines than their urban counterparts. Strategies to reduce screen time and promote healthy movement behaviours in urban areas are needed. Further studies with a larger representative sample might provide better insight across the regions within the country.

Keywords Accelerometer, 24-hour movement behaviours, Early childhood

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Background

The World Health Organization (WHO) released the first global guidelines on physical activity, sedentary behaviour, and sleep for children under 5 years of age (hereafter referred to as "the guidelines") in 2019 [1]. The guidelines focused on a 24-hour approach because, from a movement perspective, each moment in a child's day can be categorised as physical activity, sedentary behaviour, or sleep. These guidelines recommend that, over 24-hour period, children aged 3.0-4.9 years need a minimum of 180 min of physical activity. Of this, at least 60 min should be moderate- to vigorous-intensity. Children should limit screen time to less than one hour. Parents should encourage children to limit their restraining sitting to no more than an hour at a time. Children should obtain 10–13 h of good quality sleep, including naps, with regular sleep and wake up times [1]. These guidelines were developed based almost exclusively on studies from high-income countries (HICs). Children from HICs represent only 10% of children in this age group globally [2]. As a result, the WHO has called for more evidence on 24-hour movement behaviours from low- and middle-income countries (LMICs) [1]. So far, studies have reported adherence to the guidelines and socio-demographic differences [3–22]. A recent review showed that boys and children from rural areas are more active than their peers [17]. This finding prompts us to investigate whether similar differences exist in adherence to WHO guidelines in LMICs, specifically in Ethiopia. However, little data exist on 24-hour movement behaviours in Sub-Saharan African countries and none from Ethiopia [23]. The purpose of this research is to examine the proportion of Ethiopian children who met the WHO guidelines on physical activity, screen time and sleep for children under the age of five, and the associations between meeting these guidelines and socio-demographic factors (child sex, urban/rural residence and parent educational status), as a part of the SUNRISE international study adapted for the local context [24].

Methods

Study design and setting

This cross-sectional study was reported according to the *Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines* [25]. The study was conducted in kindergartens in Adama city and a rural village in Lume district, East Shewa Zone, Oromia regional state, Ethiopia. Adama city is in the South-East, about 100 km (km) from the capital, Addis Ababa. Currently, 120 kindergartens exist in the city, all of which are privately owned. Lume district has rural 35 villages, the lowest administration structure in the country, which is located about 30 km from Adama. Unlike urban areas, the population in rural Ethiopia resides in dispersed villages with limited access to infrastructures. In the rural villages of Lume district, there are no kindergartens and limited access to electricity and internet connection. Data were collected from 1st of April 2022 to 30th of September 2022. Ethiopia remained unaffected by the COVID-19 pandemic during this period and all research-type activities continued as usual.

Participants

Eligible preschool children aged 3.0-4.9 years and apparently healthy at the time of measurement that would impair their physical activity or sleep were invited to participate. A combination of random and convenience sampling was used to recruit eligible children. Convenience sampling was used to recruit 18 kindergartens in Adama city and 11 rural villages in Lume district. In the urban setting, eligible children were identified through the directors, and data collectors ensured that an equal number of boys and girls were selected from a range of economic backgrounds (parents from low-income, middle-income, high-income) based on parent profiles from the school registry. Information about the selection process was provided to the directors. Parents of eligible children were approached in person, briefed about the study using an ethics-approved participant information sheet and invited to participate by the data collectors. Parents who agreed to participate signed an ethics-approved participant consent form. A lottery method was applied manually to recruit a maximum of 20 children (10 boys/10 girls) from each kindergarten as proposed in the SUNRISE protocol [24]. In cases where more than 20 parents of eligible children agreed to participate, the maximum required number of children was randomly selected. Data were collected during school days for five consecutively days (Monday to Friday) over 24-hour period, following the SUNRISE study protocol [24]. This includes the time spent in kindergartens and at home during the day as well as night sleep. In rural areas, community health extension workers were provided list of eligible children from their health registry in each selected village. Data collectors approached parents in person, using a similar urban recruitment approach.

Measurements

Physical activity, sedentary and sleep time

Physical activity, sedentary and sleep time were measured using triaxial ActiGraph wGT3X-BT accelerometers [26], which has been validated for this age group [24, 27]. Monitors were fully charged and initialised using ActiLife (version 6.12.1) software before being attached to an elastic belt and placed on children [26]. Eligible children were asked to continuously wear the monitor under their clothes on the right hip for five consecutive days and nights. Children and their families were instructed to

remove the monitors only during water-based activities and were encouraged to refit the monitors immediately afterwards [24]. In the urban area, data collectors made daily follow-ups to check activity monitoring and compliance, while community health workers did the same in the rural setting. The monitors recorded data at a 30 Hz sampling rate. Monitor data were downloaded using ActiLife software.

Parent questionnaire

The SUNRISE parent questionnaire [24] was administered through face-to-face interviews to gather data about parents/caregivers' socio-demographics and children's screen duration, sleep quality and consistency bedtime/wake-up times. The questionnaire was translated into two local languages (Afan Oromo and Amharic language) by professional translators to suit local conditions and back translated to English. Data were collected and managed using the *Research Electronic Data Capture (REDCap)* mobile app hosted at the University of Wollongong, Australia [28, 29].

Screen and restrained sitting time

Parents reported the time their child spent using screen devices (smartphone, tablet, computer, television, or video game) in a typical 24-hour day while sitting or lying down. Parents also provided information about the amount of time their child spent as a passenger in a motor vehicle as a proxy estimate of restrained sitting during the weekdays. In this study, screen time guideline was operationalised as the time children spent on screen devices as per the WHO guidelines [1, 2].

Sleep quality

Parents were asked to rate the quality of sleep for their child using a seven-point scale ranging from 1 (very low) to 7 (very high) [24]. A brief description of the scale was given to parents. Low-quality sleep was characterised as being very difficult to settle, waking multiple times during the night for prolonged periods and very restless (tosses and turns, throws off bedclothes). High-quality sleep was characterised as settles quickly and falls asleep within a few minutes, sleeps through the night and has a very sound and deep sleep. Children who obtained less than average score (1–3) or more than average score (4–7) were categorised as having poor or good sleep quality, respectively. Parents were also asked to indicate if their child has a consistent bedtime and wake-up time. Additionally, one of the accelerometer sleep quality parameters (sleep efficiency) was reported to compliment the parent-reported sleep quality to maintain comparability across the SUNRISE study participating countries.

Bias

Steps were taken to minimise the risk of bias and confounding effects. Data consistencies were maintained by adhering to the SUNRISE study protocol [24]. Data collectors underwent two days of training. The questionnaire was translated into local languages for consistency. The team at the SUNRISE coordinating centre checked the data collected for any implausible values and missing entries. In cases where this occurred, these values were re-checked, or data were re-collected. Parent questionnaires were read out to participants directly without interpretation to avoid interviewer bias. The multivariable regression model was adjusted for the child's sex and age to control for confounding factors.

Study size

The sample size was calculated using a single-proportion formula,

$$n = \frac{z^2 p\ (1-p)}{d^2}$$

where '*n*' is the required sample size, 'z' is the statistic corresponding to the level of confidence, set at 95% (1.96), 'p' is the expected proportion of children meeting all three movement behaviour guidelines taken from a similar study conducted in Zimbabwe (24%) [15] and 'd' is the margin of sampling error tolerated (0.05).

Therefore,

$$n = \frac{(1.96)^2 0.24\ (1-0.24)}{(0.05)^2} = 280$$

Data reduction and processing

ActiGraph data were processed using the "PhysicalActivity" package (version 0.2-4) [30] in R software (version 4.2.2) [31]. The package collapses the 'gt3x' accelerometer data in 15-second epochs for physical activity using built-in functions. The "wearingMarking" function marks wear and non-wear time using an automated algorithm [30]. Then, the "markPAI" function classifies time spent in light-, moderate- and vigorous-intensity physical activity using vector magnitude and specified cut-points developed for preschool children: ≤ 25 counts/15 seconds, 25–419 counts/15 seconds, and ≥420 counts/15 seconds for sedentary time, light-intensity, and moderate-to-vigorous-intensity physical activity, respectively [27, 30, 32]. The output data were saved in readable 'csv' format. We created the total physical activity variable by combining the sum of light physical activity and moderate-to-vigorous physical activity. The "PhysActBedRest" package (version 1.1) [33] was used to identify sleep periods in 60-second epochs using a decision tree algorithm. Data

on non-wear, physical activity, sedentary time, sleep, naps and sleep efficiency were exported as 'csv' files [34]. Data were cleaned for plausible values and the acceleration time was visually checked against the original accelerometer counts from the 'Y-axis' to determine whether the child was in movement or sleep during the specified period. Data were then checked for minimum daily wear time and the number of days based on the study protocol [24]. Children who wore the monitor for a minimum of 10 hours per day during waking periods and had at least 8 hours of sleep over a 24-hour period for at least two days were included in the analyses to maintain the accuracy and reliability of the data [35].

Table 1 Characteristics of the study participants in Ethiopia ($n=381$)

Variables	Frequency (*n*)	Percentage (%)
Child sex		
Boys	196	51.4%
Girls	185	48.6%
Child age (years)		
3.0-3.99	142	37.3%
4.0-4.99	239	62.7%
Child's place of residence		
Urban	173	45.4%
Rural	208	54.6%
Parent sex[a]		
Male	75	19.9%
Female	306	80.1%
Parent age (years)[a]		
≤ 30	195	51.2%
31–50	149	39.1%
> 50	37	9.7%
Parent education level[a]		
No formal school	91	23.9%
Primary school	188	49.3%
Secondary school and above	102	26.8%
Daily accelerometer wear time		
< 10 h	29	7.6%
≥ 10 h	352	92.4%
Child sleep quality		
Good	339	89.0%
Poor	42	11.0%
Child sleep efficiency		
Good (≥ 85%)	264	69.3%
Poor (< 85%)	117	30.7%
Child consistency of bedtime and wake up		
Consistent	96	25.2%
Inconsistent	285	74.8%

[a]Of the parent who completed the questionnaire

Statistical analysis

Data were cleaned, imported and analysed in the R software (version 4.2.2) for Windows [31]. Normality was checked for continuous variables using histograms. Independent samples t-tests were used to determine the mean difference between boys and girls and children from urban and rural settings for continuous variables. Children who accumulated ≥ 180 min of total physical activity (TPA) and ≥ 60 min of moderate to vigorous-intensity physical activity (MVPA), ≤ 1 h of screen time and 10–13 hours' sleep per day were categorised as meeting the WHO physical activity, screen time, and sleep guidelines, respectively. Additionally, children who met all three guidelines were classified as meeting the combined WHO 24-hour movement guidelines [1]. Pearson's Chi-square tests were used to test if the proportion varied by sex and urban/rural setting. Additional analyses were performed to determine the proportion of children with consistent bedtimes and wake-up times. Binary logistic regression models were used to examine the associations between meeting the individual and combined WHO guidelines and socio-demographic factors (child sex, urban/rural residence and parent educational status). The multivariable regression model tested the associations between meeting physical activity, screen time, sleep, and combined guidelines (dependent variables) and child sex, place of residence and parent educational level (independent variables). All models adjusted for the duration participants wore the accelerometer to account for variations in wear time among participants. Statistical significance was set at $P<0.05$.

Results

Characteristics of the study participants

Four hundred and thirty children were recruited for this study. Nineteen participants withdrew because their parents mistakenly believed that the accelerometer might be linked to radioactive materials. Thirty children did not meet the minimum daily wear time criteria for physical activity and sleep and were excluded from the analyses. A total of 381 participants (88.6% response rate) were included in the final analyses.

Table 1 shows the characteristics of the study participants. The mean and standard deviation of children's age were 4.2 (±0.6) years. Just over half (51%) were boys and 55% were from urban areas. Nearly all children (92%) wore the accelerometer for a minimum of 10 waking hours each day. Parents reported that almost 90% of children had good sleep quality. However, only 25% of children had consistent bed and wake-up times.

Table 2 describes participants' time spent in each 24-hour movement behaviour with differences by sex and urban and rural settings. On average, children wore the accelerometer for 11.6 h per day during waking hours,

Table 2 Average time spent in 24-hour movement behaviours among children in Ethiopia ($n=381$), stratified by sex and settings

Variables	Mean (SD)			*P*-value	Mean (SD)		*P*-value
	Total	Boys	Girls		Urban	Rural	
Waking wear time (min/day)	695.2 (60.3)	698.1 (58.4)	692.1 (62.3)	0.335	697.8 (68.4)	693.0 (52.7)	0.450
Waking non-wear time (min/day)	24.1 (61.1)	24.9 (65.3)	23.3 (56.4)	0.796	38.4 (74.0)	12.3 (44.7)	**< 0.001***
MVPA (min/day)	114.4 (35.8)	122.2 (35.7)	106.1 (34.2)	**< 0.001***	98.3 (27.3)	127.7 (36.6)	**< 0.001***
TPA (min/day)	417.3 (72.0)	429.4 (72.8)	404.5 (69.2)	**0.001***	380.5 (65.0)	447.9 (62.8)	**< 0.001***
Sedentary time (min/day)	359.1(91.6)	346.6 (98.4)	372.3 (81.9)	**0.006***	406.8 (80.0)	319.4 (81.2)	**< 0.001***
Restrained sitting (min/day)	12.4 (29.4)	13.7 (35.2)	11.1 (21.7)	0.377	24.8 (39.6)	2.1 (7.1)	**< 0.001***
Screen time (min/day)	80.9 (89.2)	75.5 (85.6)	86.7 (92.7)	0.221	133.2 (90.5)	37.5 (60.2)	**< 0.001***
Sleep time (min/day)	657.5 (40.6)	660.2 (38.4)	654.7 (42.7)	0.191	641.5 (44.0)	670.9 (31.9)	**< 0.001***

Abbreviations: SD = Standard deviation; MVPA = Moderate-to-vigorous physical activity; TPA = Total physical activity. *Indicates significant difference observed at P < 0.05

Table 3 Proportion of Ethiopian children met the WHO 24-hour movement guidelines ($n=381$), stratified by sex and setting

Variable	Total *n* (%)	Boys *n* (%)	Girls *n* (%)	*P*-value	Urban *n* (%)	Rural *n* (%)	*P*-value
PA guidelines							
Meet	366 (96.1%)	192 (98.0%)	174 (94.1%)	0.090	163 (94.2%)	203 (97.6%)	0.155
Not meet	15 (3.9%)	4 (2.0%)	11 (5.9%)		10 (5.8%)	5 (2.4%)	
Screen time guidelines							
Meet	242 (63.5%)	125 (63.8%)	117 (63.2%)	0.999	66 (38.2%)	176 (84.6%)	< 0.001*
Not meet	139 (36.5%)	71 (36.2%)	68 (36.8%)		107 (61.8%)	32 (15.4%)	
Sleep guidelines							
Meet	350 (91.9%)	183 (93.4%)	167 (90.3%)	0.359	145 (83.8%)	205 (98.6%)	< 0.001*
Not meet	31 (8.1%)	13 (6.6%)	18 (9.7%)		28 (16.2%)	3 (1.4%)	
Combined guidelines							
Meet	221 (58.0%)	118 (60.2%)	103 (55.7%)	0.429	52 (30.1%)	169 (81.3%)	< 0.001*
Not meet	160 (42.0%)	78 (39.8%)	82 (44.3%)		121 (69.9%)	39 (18.7%)	

Physical activity guidelines: ≥60 min MVPA and ≥180 min TPA per day, Screen time: ≤60 min of Screen time per day; Sleep guidelines: 10–13 h of sleep per day. * Indicates statistical significance at $p<0.05$

with no difference between boys and girls and children from urban and rural settings. Children averaged 24 min of non-wear time (i.e., removal for bathing, swimming, etc.) per day, which was shorter for children in rural compared to urban areas ($p<0.001$), but there was no difference between boys and girls. Our findings showed that children had both high MVPA and TPA per day, and that this was higher in boys ($p<0.001$ for MVPA, $p=0.001$ for TPA) and in rural children ($p<0.001$). Children had 1.3 h and 10.9 h of the screen and sleep time per day, respectively. Urban children accumulated significantly more screen time ($p<0.001$) and less sleep time ($p<0.001$) than their rural peers.

Proportion of children meeting the WHO 24-hour movement guidelines

Table 3 indicates that 58% of children met the combined WHO 24-hour movement guidelines. A higher proportion of children met the physical activity (96%) and sleep guidelines (92%) compared to the screen time guideline (64%). No differences were observed between boys and girls for the proportion meeting the individual or combined guidelines. There was no difference between boys and girls as well as urban and rural children in meeting the physical activity guidelines. However, lower proportions of urban children met the screen time ($p<0.001$), sleep ($p<0.001$) and combined guidelines ($p<0.001$) compared to rural children.

Factors associated with meeting the WHO 24-hour movement guidelines

Table 4 shows that there was little association between meeting the individual and combined WHO 24-hour movement behaviour guidelines and child sex or parent educational level. In multivariate analyses, only place of residence was associated with meeting the screen time, sleep and combined guidelines. Children who lived in rural areas were more likely to meet the screen time (AOR = 7.31; 95%CI: 3.93, 14.02), sleep (AOR = 8.60; 95%CI: 3.55, 23.73) and combined (AOR = 7.41; 95%CI: 4.04, 13.97) guidelines than those who lived in urban areas.

Discussion

Summary of the main findings

Our study found that a high proportion of children met the WHO guidelines, adding a new insight from a low-income country's context. Remarkably, over 90% of children met the physical activity and sleep guidelines, while more than half met the screen time and combined

Table 4 Associations between meeting the WHO guidelines and socio-demographic factors among Ethiopian preschool children ($n=381$)

Socio-demographic factors	Meeting Physical activity guidelines		Meeting Screen time guidelines		Meeting Sleep guidelines		Meeting Combined guidelines	
	Adjusted OR (95%CI)	*P*-values	Adjusted OR (95%CI)	*P*-values	Adjusted OR (95%CI)	*P*-values	Adjusted OR (95%CI)	*P*-values
Child sex								
Boys	1		1		1		1	
Girls	0.37 (0.11, 1.10)	0.086	1.02 (0.63, 1.66)	0.920	0.79 (0.43, 1.42)	0.430	0.85 (0.52, 1.38)	0.506
Child place of residence								
Urban	1		1		1		1	
Rural	0.95 (0.23, 3.82)	0.944	7.31 (3.93, 14.02)	**< 0.001***	8.60 (3.55, 23.73)	**< 0.001***	7.41 (4.04, 13.97)	**< 0.001***
Parent educational level								
No formal schooling	1		1		1		1	
Primary school	0.20 (0.01, 1.41)	0.166	0.77 (0.36, 1.63)	0.507	1.12 (0.32, 3.68)	0.850	0.73 (0.37, 1.42)	0.353
Secondary school and above	0.12 (0.00, 1.19)	0.102	0.65 (0.25, 1.64)	0.363	1.19 (0.30, 4.44)	0.801	0.44 (0.18, 1.10)	0.080

Abbreviation: OR: Odds Ratio, CI=Confidence Interval, * Indicates statistical significance at $p<0.05$

guidelines. Children who lived in rural areas were more likely to meet the screen time, sleep and combined guidelines than those who lived in urban areas. However, the differences between boys and girls in meeting the guidelines were small and not statistically significant.

Adherence to the WHO 24-hour movement behaviours guidelines

A recent review highlighted the evidence gap in 24-hour movement behaviours among preschool children in Sub-Saharan Africa [23]. To the author's knowledge, no studies have been conducted within Ethiopia to compare with our results. We found that a high proportion of children met the individual WHO guidelines. Our finding on sleep adherence aligns with few studies [4–6, 15, 18]. Remarkably, our results were higher than those of previous studies regarding the proportion of children who met the physical activity [3, 5–10, 13, 14, 16], sleep [3, 7–11, 13, 14, 16] and screen time guidelines [3, 4, 6–9, 11, 14, 16, 19]. A possible reason for this might be lifestyle and environmental factors in Ethiopia [36]. Most children usually spent more time outdoors and engage in more unstructured play, which contributes to accumulating more physical activity [37] that may help them to sleep well due to being more physically tired [38, 39]. Almost half of Ethiopian children had limited access to screen devices due to lack of electricity in the rural areas [40], which helped them to meet the screen time guidelines. This may prevent or limit screen time before bed which would also support better sleep [41–43]. In contrast, the adherence to the screen time guidelines was lower in our study than in the study reported from China (88.2%) [10]. As suggested by Guan et al., (2020), the high levels of adherence to the screen time guidelines among Chinese children may have been related to cultural differences. Given that over 70% of parents who participated in our study have no formal education or have only completed primary school, this might have implications on our findings reported using the parent report on screen time, as affected by parental educational background [44]. In our study, over half of the children met all the combined WHO guidelines. This finding was higher than those reported in other published studies [3–16, 18, 19]. A possible reason is that a higher proportion of Ethiopian children met the physical activity and sleep guidelines.

Our study found that there was no significant difference between boys and girls in meeting the individual and combined WHO guidelines. These findings were consistent with several previous studies [9, 14, 15, 19]. Conversely, our results were in contrast with some evidence reported for combined [21, 45], physical activity [22, 45] and sleep [45]. A possible explanation for the lack of difference between boys and girls in our study relates to the parenting rules [46] and cultural context

in Ethiopia where boys and girls are free to play outside equally at preschool age.

Associations between meeting the WHO guidelines and socio-demographic factors

We found that children who lived in rural areas were over seven times more likely to meet the screen time, sleep and subsequently the combined guidelines than those who lived in urban areas. Our findings related to rural/urban differences in adherence to screen time guidelines were consistent with previous studies [14, 15, 20, 22]. However, our finding was different from a study conducted in South Africa, which reported that urban children were more likely to meet the screen time guidelines than rural children [9]. Possible reasons could include limited access to screen devices in rural Ethiopia, which could be linked to the lack of availability of electric power in the setting. Our sleep adherence was inconsistent with the two studies conducted in South Africa, which reported no urban-rural difference in meeting the sleep guidelines [9], and higher sleep adherence among urban children than their rural peers [20]. Possible reasons for this contrasting finding might be due to country contexts. Most rural children in Ethiopia have less screen time before bed and spend considerable time active outdoors, which may contribute to better sleep quality and duration than in urban children [38, 39]. Our study found that rural children were more likely to meet the combined guidelines than urban children. A possible explanation of this finding is that more rural children complied with the screen time and sleep guidelines than urban children with further research needed to confirm differences between rural and urban children in meeting the combined guidelines.

Our study did not show significant associations between meeting the physical activity guidelines and any socio-demographic factors. This finding differs from studies from Croatia, South Africa and Zimbabwe [9, 15, 22], which showed that rural children were more likely to meet physical activity guidelines than their urban peers. Most Ethiopian children from urban and rural areas met the physical activity guidelines. This may be due to children's participation in unstructured physical activities both in urban and rural areas. Ethiopia also has a low rate of private car ownership, which may encourage children to walk more to catch public transport, such as minibuses or small taxis to reach their destinations, which may contribute to achieving the required physical activity recommendations in both settings.

Recommendations

Our findings contribute to bridging the evidence gap and laying the foundation for future advocacy, research, and surveillance on 24-hour movement behaviours in this age group to ensure healthy childhood development in Ethiopia. Our study suggests that interventions focused on reducing screen time and promoting healthy movement behaviours in urban areas are needed. This study provides the first evidence from a low-income country's context. Conducting the SUNRISE main study [24], which includes a nationally representative sample of 1,000 children, would provide a greater opportunity to determine the population prevalence of guidelines adherence across the regions of Ethiopia.

Strengths and limitations

The strengths of this study include the use of device-measured physical activity and sleep data, providing quality evidence regarding adherence to the WHO guidelines and how this differed among boys and girls as well as urban and rural settings from a low-income country context. However, this study has some limitations. Convenience sampling was used to select kindergartens or rural villages, which might limit the generalisability of the findings. Accurately estimating children's screen time proved challenging for most parents, as they traditionally estimate time by observing the position of their shadows based on the Sun's movement, rather than relying on clocks or watches. Although the SUNRISE standardised protocol [24] was followed, the recall bias cannot be eliminated, and our screen time findings needs to be interpreted with caution.

Conclusions

Our study showed that a high proportion of children in Ethiopia exhibit healthy levels of 24-hour movement behaviours. However, urban children showed a lower adherence in screen time, sleep and combined guidelines, suggesting a need for targeted support in these areas.

Abbreviations

HICs	High income countries
LMICs	Low- and middle-income countries
MVPA	Moderate to Vigorous-intensity Physical Activity
REDCap	Research Electronic Data Capture
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
TPA	Total Physical Activity
WHO	World Health Organisation

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Author contributions
CA conceptualised the study, processed and analysed data, interpreted results and was a major contributor in writing the manuscript. DC, KK and ADO conceptualised the study. KHC and DA were involved in data processing and interpreting the results. AD, SG and DT interpreted the results and edited the manuscript. All authors reviewed and approved to the final manuscript.

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Data availability
Data that support the findings of this study are available upon a reasonable request.

Declarations

Ethics approval and consent to participate
Ethics approval was obtained from the University of Wollongong Human Research Ethics Committee, Australia (IHRERC/2018/044) and the Institutional Health Research Ethics Review Committee at Adama Hospital Medical College, Ethiopia (AHMC/SR/31/01/2022). Participant information sheet provided, and informed written consent was signed by parents/caregivers for their children and themselves before participating in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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