Journal of Physical Activity and Health, 2024, 21, 283-293
https://doi.org/10.1123/jpah.2023-0511
© 2024 Human Kinetics, Inc.

Human Kinetics
ORIGINAL RESEARCH

Prevalence and Health Associations of Meeting the World Health Organization Guidelines for Physical Activity, Sedentary Behavior, and Sleep in Preschool-Aged Children: The SUNRISE Mongolia Pilot and Feasibility Study

Ankhmaa Byambaa,[1,2,3] Oyundelger Dechinjamts,[3] Bayasgalan Jambaldorj,[3] Rachel A. Jones,[1,4] Kar Hau Chong,[1,2] and Anthony D. Okely[1,2]

[1]Early Start, University of Wollongong, Wollongong, NSW, Australia; [2]School of Health & Society, Faculty of the Arts, Social Sciences and Humanities, University of Wollongong, Wollongong, NSW, Australia; [3]National Center for Public Health, Ulaanbaatar, Mongolia; [4]School of Education, Faculty of the Arts, Social Sciences and Humanities, University of Wollongong, Wollongong, NSW, Australia

Background: There is a lack of evidence regarding 24-hour movement behaviors of young children from low- and middle-income countries. This study examined Mongolian preschoolers' adherence to the World Health Organization's guidelines for physical activity, sedentary behavior, and sleep; their associations with health indicators, and the feasibility of the SUNRISE International study in Mongolia. ***Methods:*** Preschool-aged children were recruited from 5 kindergartens in urban and rural areas of Ulaanbaatar city and Tuv province in Mongolia. Physical activity and sedentary behavior were measured by an ActiGraph accelerometer worn for 5 consecutive days. Screen time and sleep were reported by parents. The National Institute of Health and Early Years Toolboxes were used to assess motor skills and executive function, respectively. ***Results:*** One hundred and one children participated in the study (mean age = 4.82 y, boys = 58), with 88% (n = 89) having complete data for analysis. The proportion of children who met the recommendations for physical activity, sedentary screen time, and sleep was 61%, 23%, and 82%, respectively. Only 7% met all recommendations. Meeting the sleep recommendation individually ($P = .032$) and in combination with the physical activity recommendation was associated with better gross ($P = .019$) and fine ($P = .042$) motor skills. Spending more time in physical activity was positively correlated with motor development. Results confirmed that the SUNRISE study protocol was feasible, age-appropriate, and enjoyable for children. ***Conclusions:*** The results of the SUNRISE pilot study will help inform the SUNRISE Mongolia main study and lay the groundwork for future research into children's 24-hour movement behaviors in Mongolia.

Keywords: guidelines and recommendations, accelerometry, 24-hour movement behaviors, kindergarten

The childhood obesity epidemic is proliferating worldwide, with an estimated 39 million children under the age of 5 years classified as overweight or obese.[1] Obesity poses a severe health risk later in life (ie, reduced life span) and may lead to the premature development of noncommunicable diseases (such as diabetes, cancer, liver disease, stroke, and hypertension).[1–4]

24-hour movement behaviors play a crucial role in preventing childhood obesity.[5] This new paradigm combines physical activity, sedentary screen time, and sleep performed throughout a day and focuses on understanding their interrelation and synergistic health impact.[6,7] The release of the World Health Organization's (WHO) *guidelines on physical activity, sedentary behavior, and sleep for children under 5 years* (referred to as 24-h movement guidelines) has formalized this concept on a global level.[8] However, these guidelines were developed based on evidence almost exclusively from high-income countries due to the paucity of research from low- and middle-income countries (LMICs).

Dechinjamts https://orcid.org/0009-0000-5880-6216
Jones https://orcid.org/0000-0002-5384-1941
Chong https://orcid.org/0000-0002-3893-4306
Okely https://orcid.org/0000-0002-1626-8170
Byambaa (ab522@uowmail.edu.au) is corresponding author, https://orcid.org/0000-0003-2504-0239

Systematic reviews show that meeting the 24-hour movement guidelines is associated with better health-related quality of life, social–cognitive development, mental and emotional health, motor development, and fitness in preschool children.[9–11] On the contrary, children not meeting the guidelines may be at higher risk of developing overweight and obesity.[9,12] Given that children in their early years are undergoing rapid physical, cognitive, and socio-emotional development and are open to behavioral modification, it is important to understand and promote healthy movement behaviors during this period.[13] Yet, research involving children younger than school-age remains scarce.

Since the release of the WHO guidelines[8] and country-specific guidelines (eg, Canada,[14] Australia,[6] South Africa,[15] and Asia-Pacific region[16]), research interest is turning to investigating children's adherence to them. Compliance with these guidelines has been assessed in various studies, predominantly in high-income countries.[9,17] A recent systematic review involving 23 countries (80% high income) reported a low prevalence of meeting the guidelines, 11% of preschoolers complied with all 3 guidelines, and 9% did not comply with any of the guidelines.[17] In the Asian region, compliance rates with integrated guidelines vary widely ranging from 2.9% to 17.5%.[18,19] For instance, preschoolers in China and Hong Kong have high compliance (88% and 68%, respectively) for sedentary screen time recommendation, while only around 17% of children in Japan and Bangladesh adhere to

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

this recommendation.[12,18–20] However, there is a dearth of evidence on compliance with the guidelines and their association with health among children from LMICs and none from Mongolia.[5,9]

The SUNRISE International Study of Movement Behaviors in the Early Years (https://sunrise-study.com/) aims to create an international surveillance system of preschool-aged children's movement behaviors by assessing the proportion of children worldwide adhering to the WHO guidelines, with a focus on LMICs.[5] Before conducting the SUNRISE study with a large, nationally representative sample, it is important to test the feasibility and acceptability of the study protocol in a country-specific context.[5] This is a routine procedure for the SUNRISE study, and to date, pilot studies have been carried out in 39 countries with published findings from Vietnam,[21] Bangladesh,[19] Zimbabwe,[22] South Africa,[23] Japan,[20] and Sweden.[24] In Mongolia, the SUNRISE pilot study was designed and piloted in 2019. Mongolia is a landlocked LMIC located in Central Asia, with a population of 3.4 million, of which 70% live in urban areas.[25]

This study aimed to (1) report the proportion of Mongolian preschool children who meet the WHO 24-hour movement guidelines; (2) examine associations between movement behaviors and children's health indicators (body mass index [BMI]-for-age *Z* score, executive function, and motor skills; and (3) determine the feasibility of the methods for implementing the SUNRISE main study in Mongolia. Study results will provide preliminary evidence crucial for informing public health policy and interventions to promote healthy levels of movement behaviors among young children in Mongolia. Pilot study findings will shape subsequent main study and serve as a foundation for further research.

Materials and Methods

Study Design and Participants

This study used a cross-sectional design. Ethical approval was obtained from the Mongolian Ministry of Health's Medical Ethics Committee (ref.138, December 26, 2019) and the University of Wollongong Human Ethics Research Committee (ref. 2018/044).

In Mongolia, preprimary education service was not compulsory and was provided for children aged 3–5 years at the time of data collection. However, with the pass of a new law in July 2023, preprimary education now includes 2-year-olds and is compulsory for 5-year-old children. The majority of children (86.5%) in Mongolia have access to preprimary education and attend kindergartens full time.[26] In our context, the term "preschool" was exclusively used to denote the age of children. Whereas the term "kindergarten" was used to denote the educational facility attended by children aged 2–5 years old, aligning with common usage in Mongolia.

Participants were recruited using convenience sampling from 3 kindergartens in Ulaanbaatar city and 2 kindergartens in Tuv province. The Ministry of Education and Science's Department of Preschool Education assisted in identifying kindergartens for the data collection. We aimed to include 1 urban and 1 rural kindergarten in each province/city. However, Ulaanbaatar city does not have rural areas by the official definition. Thus, 1 kindergarten located on the city's outskirts in the ger district of Dambadarjaa (Sukhbaatar district) was recruited as a proxy for rural setting in Ulaanbaatar city.

Data collection occurred between December 2021 and April 2022. Directors from chosen kindergartens were contacted and invited to participate in the study. Following confirmation from the directors, parents/primary caregivers of children enrolled in the kindergartens were invited to a meeting with researchers. The research study was explained at meetings held at the respective kindergartens outside of working hours, while adhering to COVID-19 safety guidelines. Parents interested in participating were provided with an information sheet and consent form. Children were eligible to participate if they were 3–5 years of age and attending the kindergarten on a regular basis. Children were ineligible if they had any type of disability or impairment and were not able to wear an accelerometer for 5 consecutive days. Only children with written parental consent were recruited into the study.

Data collection was performed by a team of 8 experienced researchers from the National Centre for Public Health of Mongolia with backgrounds in pediatrics, public health, and nutrition. Before the commencement of the data collection, researchers were trained in the study protocol by the SUNRISE Coordinating Center. All materials were translated into Mongolian, including information sheets, consent forms, questionnaires, and log sheets. Data collection took place in each kindergarten during the school day. Data were collated using Research Electronic Data Capture (REDCap) software (Vanderbilt University).[27]

Measurements

All measurements followed the SUNRISE study protocol published elsewhere.[5]

- *Height and weight measurements* were taken using a portable height measuring board (UNICEF) and calibrated scales (SECA 876) according to WHO protocol.[28] Measurements were taken twice, and the third was taken if they differed by >0.25 kg for weight and 0.5 cm for height. BMI *Z* scores were then calculated using WHO AnthroPlus software and used in the classification of children's body weight status based on WHO growth standards.[29,30]
- *Physical activity and sedentary time* were measured using waist-worn ActiGraph GT3X+/GT3X-BT accelerometers (Actigraph LLC). Accelerometers were set to start recording at the sample rate of 30 Hz from midnight of the day when the monitors were given to the children. Children were instructed to wear the monitor for 24 hours per day over 5 consecutive days, except when bathing, swimming, or engaging in water-based activities. Teachers monitored the children's compliance with requirements for wearing monitors during kindergarten hours, while parents monitored them outside of kindergarten hours. Raw data were downloaded from the monitors and reintegrated into 15-second epochs for analysis using a low-frequency filter via ActiLife software (version 6.12.1). To be included in the analysis, participants were required to have at least 24 hours of valid data (confirmed through visual inspection of the data files), with at least 6 hours of valid wear time during the waking period per day.[31] A predetermined time filter (ie, 8 AM–10:20 PM based on the average parent-reported wake-up and bedtime of the study population) was applied to all valid 24-hour day(s) to exclude sleeping periods from the analysis of physical activity and sedentary time. Furthermore, any waking period(s) of 20 minutes or more consecutive 0 counts were defined as nonwear and excluded from the analysis.[32] Validated intensity cut points were applied to classify valid waking wear time as sedentary time (<800 counts per minute [CPM]), light-intensity physical activity (800–1679 CPM), moderate- to vigorous-intensity physical activity (MVPA; ≥1680 CPM), or vigorous-intensity physical activity (VPA; =>3368 CPM).[33,34]

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

- *Sleep and screen time* were assessed by a self-administered parent questionnaire.[5] Parents/primary caregivers were given hard copies of the questionnaires and were asked to complete them at a convenient time. Completed questionnaires were collected in kindergartens by teachers and handed over to the researchers. The following questions were used to report sleep and screen time, respectively: *How many hours of sleep does this child get in a typical 24-hour day (including naps)? On a 24-hour period in the past week, how much time did the child who is participating in this study spend using any electronic screen device such as smart phone, tablet, video game, or watch TV or movies, videos on the internet while they were sitting or lying down? Please record this as accurately as you can to the nearest minute.*
- *Executive functions of working memory and inhibition* were assessed using 2 games from the Early Years Toolbox (www.eytoolbox.com.au).[35] Both games had been translated into Mongolian. "Mr Ant" assesses the child's visual–spatial working memory. Children were asked to remember the location of colored stickers on the cartoon character's body (Mr Ant). Stickers were then removed from the character, and children were asked to recall the location of the stickers. A point was awarded for each subsequent level at which the child correctly performed at least 2 attempts. The scores ranged from 0 to 8. The "go/no-go" task measures inhibition or the ability to control impulsive responses. Participants were required to tap on the screen on "go" trials (when the fish appears) and avoid tapping on "no-go" trials (when the shark appears). The score ranged from 0 points (if performance was incorrect on all attempts) to 1 point (if performance was perfect on both fish and shark trials).
- *Motor skills* (dexterity, functional mobility, postural steadiness, lower, and upper body strength) were assessed using the National Institutes of Health Toolbox validated tests.[36] The 9-hole pegboard test was used to assess dexterity. The test was performed with each hand twice (1 practice and 1 trial). Children were required to place pegs in 9 holes in any order and return them to the initial place, holding one at a time. Research staff measured the time required to perform the test with each hand, with shorter duration indicating better dexterity. The Supine Timed up and Go was used to assess functional mobility. The children laid on their backs with their feet on the start line 3 m from the wall. After a demonstration from a data collector, a child was required to get up and run as quickly as possible to the wall, touch the "target" on the wall, and run back. The data collector recorded the time the child returned to the start line, with shorter duration indicating better functional mobility. The test was performed 3 times, with 1 practice and 2 trials. Postural steadiness was assessed using a 1-leg standing balance test. The child stood on each leg with their arms held freely for up to 30 seconds, with longer duration indicating better postural steadiness. The data collector first demonstrated the test and then practiced once with the participant, after which trials were timed. A standing long jump test assessed explosive lower body strength. The test was performed with at least 1 practice and 2 trials. Children were required to place their feet behind the line and jump as far as possible, landing on both feet. A further distance recorded indicates greater lower body strength. A hand grip dynamometer was used to assess upper body strength. The assessor recorded the force to the nearest 0.5 kg, with greater values indicating higher upper body strength. Participants were given 2 trials for each hand.
- *The feasibility of the SUNRISE study protocol and measurements* in Mongolia was assessed based on the overall compliance rate with the protocol and feedback from parents and teachers via focus groups:

a. The feasibility was partially assessed by successful participant recruitment, with equal representation from urban/rural areas and boys/girls. Criteria for successful recruitment were: (1) recruiting a total of 100 children with 20 children from each kindergarten and (2) successfully collecting data on ≥90% of participants who gave consent to participate.

b. Measurements were evaluated by observing how well participants and staff followed the protocol and completed the measurements. For the accelerometer measurements, having at least 24 hours of valid data (with at least 6 h of valid wear time during the waking period per day) from ≥80% of participants who wore the accelerometers was considered as a successful response rate.

c. As part of the study's feasibility assessment, focus groups were conducted in each kindergarten. Focus group discussions were held with 2 to 5 respondents consisting of parents and kindergarten staff. The aim was to gain insight into their opinions and experiences after participating in the study to inform the data collection protocol of the subsequent main study.[5] Discussions lasted for an average of 15 to 20 minutes and took place on the final day of data collection at each kindergarten. Respondents were asked the following questions: *Did the children enjoy participating? Was there anything you think they did not enjoy or that could be improved? How did you find your child/the children went wearing the accelerometer for 5 days? Were there any problems? If so, can you tell us about them and offer any advice on how we could improve this? Do you have any other comments to make?*

Notes taken during the focus groups were translated to English and entered into REDCap.

Statistical Analyses

Statistical analyses were performed using Jamovi software (version 2.2.5, The Jamovi Project).[37] Descriptive statistics (mean and SDs or frequency and percentage) were used to summarize all study variables. Differences between sexes and urban or rural areas were tested using an independent t test (or Mann–Whitney U test for nonparametric data) for continuous variables and Pearson's chi-squared test for categorical variables. Children were classified as meeting the guidelines if they: (1) had at least 180 minutes of total physical activity per day, including 60 minutes of MVPA, (2) had ≤60 minutes of sedentary screen time and restrained sitting up to 60 minutes at a time, and (3) had 10 to 13 hours of sleep including naps.[8]

Associations of movement behaviors with health indicators were analyzed in 2 ways. First, differences in health indicators (BMI-for-age Z score, executive function, and motor skills) between participants who met and did not meet the movement guidelines were examined using a Mann–Whitney U test. Second, Spearman rank correlation coefficients were used to detect the association between times spent in various movement behaviors and BMI-for-age Z score, executive function, and motor skills. Statistical significance was set at $P < .05$. Focus group results were analyzed using thematic analysis.[38]

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

Results

Participant Characteristics

One hundred and one children participated in the study (mean age = 4.82 y, boys n = 58), with 88% (n = 89) having valid data for all measurements. Table 1 shows the descriptive characteristics of participants and time spent in movement behaviors. Around 12% of children were classified as overweight, and 11% were at risk of developing overweight. Girls spent significantly less time in total physical activity ($P \leq .001$), MVPA ($P \leq .001$), and VPA ($P \leq .001$), but more time in sedentary activities ($P = .014$) compared with boys. No significant differences were observed in screen time and sleep duration between girls and boys and between urban and rural children.

Adherence to the WHO Guidelines

The proportion of children who met the WHO guidelines for physical activity, sedentary screen time, and sleep was 61%, 23%, and 82%, respectively (Table 2). Only 7% met all recommendations. The proportion of meeting the physical activity recommendation (77% vs 39%; $P < .001$) and the integrated guidelines (8% vs 5%; $P = .021$) was significantly higher among boys than girls.

Association of Movement Behaviors With Health Indicators

The association between meeting individual and combined guidelines and health indicators is presented in Table 3. Children who met the physical activity ($P = .089$) or sleep recommendations ($P = .032$) had better lower body strength. Children who met the combined recommendations for physical activity and sleep had better results for functional mobility ($P = .078$), lower body strength ($P = .019$), and dexterity ($P = .042$) than children who did not. Meeting the guidelines was not associated with any of the executive functions. No significant differences were observed in BMI-for-age Z scores between those who met the guidelines and those who did not.

Time spent in MVPA was associated with various motor and cognitive skills (Table 4). Specifically, greater time spent in MVPA was associated with better functional mobility (ie, shorter time to complete the Supine Timed up and Go test; $r = -.272$, $P = .008$) and higher lower body strength ($r = .340$, $P < .001$), and marginally associated with better upper body strength ($r = .202$,

Table 1 Descriptive Characteristics and Time Spent in Movement Behaviors

	Total, n = 101	Boys, n = 58	Girls, n = 43	P[a]	Urban, n = 52	Rural, n = 49	P[b]
Age	4.82 (0.76)	4.89 (0.75)	4.73 (0.77)	.316	4.89 (0.77)	4.74 (0.74)	.396
Weight, kg	18.7 (3.07)	19.3 (2.63)	18.0 (3.50)	**.029**	19.44 (2.73)	17.98 (3.26)	**.019**
Height, cm	108.0 (7.01)	109.0 (6.78)	107.0 (7.21)	.143	110.38 (6.35)	105.74 (6.93)	**.002**
BMI, kg/m^2	15.9 (1.42)	16.2 (1.20)	15.6 (1.64)	**.008**	15.9 (1.34)	15.96 (1.51)	.992
TPA, min/d[c]	192 (42.9)	204 (41.3)	175 (39.4)	**<.001**	184.6 (41.88)	199.27 (42.96)	.097
MVPA, min/d	92.8 (28.9)	102.1 (29.2)	79.5 (22.9)	**<.001**	89.7 (26.69)	95.79 (30.81)	.463
VPA, min/d	22.1 (11.4)	25.6 (12.72)	16.9 (6.55)	**<.001**	22.1 (9.72)	22 (12.92)	.551
Sedentary behavior, min/d	603.0 (47.1)	594.0 (43.1)	615.0 (50.2)	**.014**	606.6 (47.7)	599 (46.71)	.519
Screen time, min/d[d]	140.0 (97.2)	148.0 (113.2)	131.0 (71.9)	.650	152.75 (111.45)	127.63 (78.97)	.468
Sleep, min/d[e]	667.0 (70.8)	671.0 (64.4)	662.0 (78.6)	.838	673.12 (65.47)	660.16 (76.06)	.422

Abbreviations: BMI, body mass index; MVPA, moderate to vigorous physical activity; n, number of children; TPA, total physical activity; VPA, vigorous physical activity.
Note: The values are presented as mean (SD).
[a]Differences between sexes were tested using the Mann–Whitney U test. [b]Differences between urban or rural samples were tested using the Mann–Whitney U test. [c]For all types of physical activity and sedentary behavior: total n = 95; boys n = 56; girls n = 39; urban = 46; rural = 49. [d]For screen time: total n = 96; boys n = 54; girls n = 42; urban = 49; rural = 47. [e]For sleep: total n = 98; boys n = 55; girls n = 43; urban = 50; rural = 48.

Table 2 Number and Proportion of Participating Children Meeting Each Recommendation of the WHO Guidelines for Physical Activity, Sedentary Behavior, and Sleep for Children Aged Under 5 Years, by Sex and Location

WHO recommendations	Total, n (%)	Boys, n (%)	Girls, n (%)	P	Urban, n (%)	Rural, n (%)	P
≥60-min MVPA and ≥180-min TPA per d[a]	58 (61.1%)	43 (76.8%)	15 (38.5%)	**<.001**	25 (55.6%)	33 (66%)	.297
≥60-min MVPA per d	86 (90.5%)	52 (92.9%)	34 (87.2%)	.353	40 (88.9%)	46 (92%)	.605
≥180-min TPA per d	58 (61.1%)	43 (76.8%)	15 (38.5%)	**<.001**	25 (55.6%)	33 (66%)	.297
≤60-min screen time per d[b]	22 (22.9%)	14 (25.9%)	8 (19%)	.426	12 (25%)	10 (20.8%)	.627
<1-h restrained sitting per d[C]	77 (77.8%)	43 (76.8%)	34 (79.1%)	.786	40 (81.6%)	37 (74%)	.361
10–13 h of sleep per d	81 (81.8%)	49 (87.5%)	32 (74.4%)	.094	43 (87.8%)	38 (76%)	.129
Meeting all recommendations[d]	6 (6.7%)	4 (7.7%)	2 (5.3%)	**.021**	4 (9.5%)	2 (4.2%)	.535

Abbreviations: MVPA, moderate to vigorous physical activity; n, number of children; TPA, total physical activity; WHO, World Health Organization.
[a]For physical activity: total n = 95; boys n = 56, girls n = 39. [b]For screen time: total n = 96; boys n = 54, girls n = 42. [c]For restrained sitting and sleep: total n = 99, boys n = 56, girls n = 43. [d]For all recommendations: total n = 90, boys n = 52, girls n = 38.

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

Table 3 Association Between Meeting the WHO Guidelines and Health Indicators

	PA		Screen		Sleep		PA + screen		PA + sleep		Screen + sleep		Restrained sitting		All guidelines	
Guidelines	**Yes (61.1%)**	**No (38.9%)**	**Yes (22.9%)**	**No (77.1%)**	**Yes (81.8%)**	**No (18.2%)**	**Yes (11.1%)**	**No (88.9%)**	**Yes (51.6%)**	**No (48.4%)**	**Yes (16.7%)**	**No (83.3%)**	**Yes (77.8%)**	**No (22.2%)**	**Yes (6.7%)**	**No (93.3%)**
BAZ																
Median	0.34	0.22	0.32	0.26	0.38	0.10	0.45	0.23	0.39	0.22	0.32	0.26	0.18	0.83	0.18	0.29
IQR	−0.12 to 0.98	−0.21 to 0.99	−0.05 to 0.75	−0.20 to 0.99	−0.14 to 0.97	−0.31 to 1.06	0.14 to 0.97	−0.21 to 0.99	−0.08 to 0.86	−0.22 to 0.99	0.06 to 0.59	−0.21 to 1.01	−0.21 to 0.76	0.23 to 1.25	−0.02 to 0.45	−0.19 to 1.01
MR	48.76	46.81	47.20	48.89	50.91	45.89	50.80	44.84	48.56	45.33	46.25	48.95	47.12	60.09	37.83	46.05
P	.737		.804		.502		.496		.564		.723		**.062**		.457	
Functional mobility																
Median	5.0	5.5	5.5	5.0	5.0	5.5	5.5	5.0	5.0	5.5	5.5	5.0	5.0	5.5	6.0	5.0
IQR	4.5 to 6.37	5.0 to 7.0	4.5 to 6.5	4.5 to 6.5	4.5 to 6.5	5.0 to 6.75	4.5 to 6.37	4.5 to 6.5	4.37 to 6.12	4.5 to 7.0	4.5 to 6.87	4.5 to 6.5	4.5 to 6.5	4.5 to 6.5	4.87 to 6.37	4.5 to 6.5
MR	44.46	53.55	54.36	46.76	48.57	56.42	49.75	44.97	42.26	52.06	51.63	47.88	48.93	53.75	52.42	45.01
P	.114		.257		.291		.582		**.078**		.620		.484		.499	
Postural steadiness																
Median	16.25	16.5	16.75	15.75	16.50	14.00	14.00	16.25	17.75	14.50	18.25	15.25	16.50	14.25	14.00	16.25
IQR	9.12 to 24.25	7.0 to 25.0	7.0 to 24.25	9.5 to 24.87	9.0 to 25.5	8.25 to 19.87	6.37 to 23.37	9.37 to 25.0	11.37 to 25.5	7.0 to 24.5	7.0 to 25.5	9.0 to 24.5	9.0 to 25	7.0 to 23.37	6.5 to 21.87	9.0 to 25.0
MR	47.66	47.25	46.77	49.01	51.72	42.25	41.55	45.99	50.61	43.14	50.34	48.13	50.68	47.61	38.83	45.98
P	.944		.740		.206		.612		.182		.772		.658		.518	
Lower body strength																
Median	87.75	76.25	81.75	81.00	82.50	72.50	90.00	81.00	90.00	76.50	76.25	81.75	81.50	77.75	74.50	82.25
IQR	72.5 to 100.12	65.37 to 93.25	68.12 to 99.12	67.25 to 98.12	70.5 to 100	64.0 to 84.25	73.5 to 97.87	66.75 to 99.12	75.5 to 103.37	63.0 to 92.5	65.25 to 102.5	68.75 to 98.12	68.0 to 99.5	64.62 to 92.37	69.12 to 92.25	67.75 to 99.12
MR	51.27	41.43	49.59	48.18	52.93	36.83	51.15	44.79	53.38	40.20	47.66	48.67	51.23	45.70	41.67	45.77
P	**.089**		.834		**.032**		.468		**.019**		.894		.426		.710	
Upper body strength																
Median	7.25	6.56	6.80	7.00	7.50	6.37	6.93	7.00	7.75	6.62	7.25	6.93	7.00	6.25	6.00	7.00
IQR	5.4 to 9.68	5.16 to 8.53	4.22 to 8.68	5.37 to 9.68	5.25 to 9.75	5.34 to 6.96	5.75 to 8.68	5.16 to 9.56	5.25 to 9.75	5.25 to 8.5	3.87 to 9.06	5.37 to 9.40	5.37 to 9.37	4.31 to 8.84	4.0 to 8.37	5.34 to 9.40
MR	50.26	43.06	43.23	50.07	52.09	40.58	42.00	45.94	51.13	42.60	45.34	49.13	51.56	44.55	35.25	46.23
P	.213		.312		.124		.653		.128		.619		.312		.320	

(continued)

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

Table 3 *(continued)*

Guidelines	PA		Screen		Sleep		PA + screen		PA + sleep		Screen + sleep		Restrained sitting		All guidelines	
	Yes (61.1%)	No (38.9%)	Yes (22.9%)	No (77.1%)	Yes (81.8%)	No (18.2%)	Yes (11.1%)	No (88.9%)	Yes (51.6%)	No (48.4%)	Yes (16.7%)	No (83.3%)	Yes (77.8%)	No (22.2%)	Yes (6.7%)	No (93.3%)
Dexterity																
Median	34.5	35.75	35.25	34.50	34.50	35.00	33.75	35.00	33.00	36.00	35.75	34.50	34.00	35.50	33.75	35.00
IQR	31.0 to 39.0	31.37 to 48.5	31.5 to 39.0	30.62 to 41.25	30.0 to 42.0	32.62 to 37.25	31.5 to 37.12	30.87 to 42.37	30.4 to 37.5	32.5 to 48.5	30.62 to 41.75	30.87 to 40.75	31.0 to 39.5	32.0 to 41.87	33.0 to 35.62	30.50 to 42.37
MR	45.18	51.24	50.89	47.79	49.28	53.25	42.50	45.88	41.50	52.87	50.09	48.18	48.33	55.84	41.67	45.77
P	.295		.647		.595		.700		**.042**		.802		.279		.710	
Working memory																
Median	2.33	2.0	2.16	2.33	2.33	2.00	2.33	2.33	2.33	2.00	3.00	2.16	2.33	2.00	3.00	2.33
IQR	2.0 to 3.0	1.5 to 3.0	1.58 to 3.0	2.0 to 2.9	2.0 to 3.0	2.0 to 2.58	2.0 to 3.0	2.0 to 3.0	2.0 to 3.0	1.66 to 2.83	1.5 to 3.0	2.0 to 2.66	2.0 to 3.0	2.0 to 2.83	2.0 to 3.33	2.0 to 3.0
MR	46.6	42.53	45.05	45.63	48.17	42.14	44.33	42.28	47.33	40.59	50.14	44.64	48.21	43.09	50.50	41.99
P	.461		.929		.387		.809		.207		.462		.430		.443	
Inhibition																
Median	0.76	0.68	0.66	0.76	0.76	0.74	0.73	0.75	0.76	0.67	0.69	0.76	0.75	0.87	0.73	0.75
IQR	0.56 to 0.88	0.55 to 0.85	0.56 to 0.79	0.57 to 0.85	0.57 to 0.87	0.58 to 0.83	0.58 to 0.83	0.55 to 0.85	0.60 to 0.88	0.54 to 0.85	0.56 to 0.86	0.57 to 0.85	0.56 to 0.85	0.63 to 0.86	0.60 to 0.78	0.55 to 0.85
MR	46.34	41.71	39.17	47.31	47.92	43.17	43.50	42.38	47.97	39.94	42.46	46.06	46.20	49.59	44.30	42.39
P	.406		.220		.502		.896		.138		.636		.606		.865	

Abbreviations: BAZ, BMI-for-age *Z* score; BMI, body mass index; IQR, interquartile range as 25th to 75th percentile; MR, mean ranks; PA, physical activity. Note: "Yes" indicates meeting the guidelines. "No" indicates not meeting the guidelines.

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

Table 4 Correlation Between Times Spent in Movement Behaviors and Health Indicators

	BAZ	Functional mobility	Postural steadiness	Lower body strength	Upper body strength	Dexterity	Working memory	Inhibition
MVPA, min/d	−.013	**−.272****	.057	**.340*****	.202	−.158	.103	.183
Total physical activity, min/d	−.001	−.160	−.032	**.222***	.120	−.084	.077	.097
Total sedentary time, min/d	.002	.095	.070	−.104	−.042	.000	−.040	−.143
Sleep time, min/d	−.050	.022	−.029	.064	−.027	.031	.060	.022
Screen time, min/d	.034	**−.228***	.042	.122	**.242***	−.067	.050	.099

Abbreviations: BAZ, BMI-for-age *Z* score; BMI, body mass index; MVPA, moderate to vigorous physical activity; *r*, Spearman correlation coefficient.
*Indicates significance at $P \le .05$. **Indicates significance at $P \le .01$. ***Indicates significance at $P \le .001$.

$P = .051$). Daily screen time was associated with functional mobility ($r = -.228$, $P = .026$) and upper body strength ($r = .242$, $P = .018$). These associations were in the nonhypothesized direction, indicating that children who had more screen time completed the assessment for functional mobility faster and had higher scores for upper body strength. A weak positive association was observed between total time engaged in physical activity and lower body strength ($r = .222$, $P = .031$).

Feasibility of the SUNRISE Protocol

The feasibility of SUNRISE International study methods in Mongolia was based on the overall compliance rate with the protocol and feedback from parents and teachers via focus groups. Of the participating children, 94% (n = 95) had at least 1 day of accelerometry data, 91% (n = 92) had 2 days of data, and 83% (n = 84) had 3 or more days of data. The main reason for not complying with the ActiGraph accelerometer protocol was the frequent removal of the device, especially at night and during the initial days of wearing. Gross and fine motor skill assessments were feasible in a typical kindergarten setting in Mongolia, with only one child refusing to participate in the assessments. All participants attempted the executive function assessments. However, 3 children initially had minor issues with playing the iPad games. Two children refused to play, and 1 child could not concentrate on the games, but after positive encouragement from the data collector and teacher, they agreed to continue participating in the games. Focus group results confirmed that the methods were feasible, age-appropriate, and enjoyable for children. Parents reported that all questions in the parent questionnaire were clear to understand. Parents and kindergarten staff agreed that children enjoyed participating in the study and undertaking the assessments.

> Children really liked all the activities and especially games on iPad. Afterward they were telling about it to their classmates and parents. (Teacher 2 from kindergarten MN03)

Regarding wearing the accelerometer for 5 consecutive days, parents reported that the overall experience was fine, but sometimes children felt uncomfortable, especially on the first day and when sleeping.

> Sometimes he (child) felt not comfortable wearing it (accelerometer). Especially during sleep time, he was saying that it was squeezing his belly. (Participant 1 from kindergarten MN01)

Some parents suggested improving the accelerometer compliance by reducing the total wear time from 5 to 3 days, taking breaks of 1 to 2 days in the middle of 5 consecutive days, and wearing the device on the wrist instead of the hip.

Discussion

Approximately one-quarter, three-fifths, and four-fifths of children met the WHO guidelines for screen time, physical activity, and sleep, respectively. Less than 10% met all recommendations. Meeting sleep guidelines individually and in combination with physical activity was associated with better gross and fine motor development. Spending more time in physical activity (especially MVPA) was positively correlated with motor development. Results confirmed that the study protocol was feasible, age-appropriate, and enjoyable for children.

The Proportion of Children Meeting the WHO Guidelines

Compared with other participating countries in the SUNRISE Study, the proportion of Mongolian children meeting all recommendations was higher than those reported for Bangladesh (5%)[19] and similar for those reported for Japan (7%).[39] A considerably lower percentage of preschool children met all recommendations compared to China,[12] Vietnam,[21] Zimbabwe,[22] and South Africa.[23] Similar to other countries,[10,19,39,40] low compliance with the combined movement guidelines in Mongolia was driven by the low compliance with the sedentary screen time recommendation. Our findings align closely with the results of the Mongolian National Statistics Office's longitudinal household survey, which reported that 78% of children in Mongolia between the ages of 3 and 4 years spent >1 hour per day in front of screens. Additionally, half of the parents reported having no concerns about their child's screen time.[41] These findings suggest that parents may lack awareness about the harmful impact of excessive screen time (especially for recreational purposes) and may not feel concerned about limiting their children's screen time. Therefore, strategies and interventions are necessary to raise awareness among parents and promote adherence to the sedentary screen time guidelines among young children. Currently, there are no policies in Mongolia regarding the impact of prolonged screen time on children's health.

The proportion of children meeting physical activity guidelines varied across countries, with higher proportions reported in Zimbabwe,[22] Japan,[39] South Africa,[23] and Bangladesh.[19] Our findings were similar to the results of Guan et al.[12] The reasons for the lower proportion of Mongolian children adhering to the physical activity guidelines might be multifaceted, for example, children spending more time indoors, safety concerns, and less access to appropriate outdoor environments.[42] Studies show that outdoor play is a strong predictor of physical activity.[42,43] Data were collected in Mongolia during winter and spring seasons. While March and April are considered as spring months, temperature continues to fluctuate

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

and the persistent cold, coupled with elevated air pollution, discourages parents from permitting outdoor play. Furthermore, kindergartens in Mongolia change their schedules during the cold months, removing outdoor play times for similar reasons. Although children in countries with similar winter weather, such as Canada and Finland, continue to participate in outdoor activities despite the season,[43] a key difference between Mongolia and these countries is that Mongolia experiences extreme air pollution during cold months, with an average concentration of particulate matter of 80 to 140 $\mu g/m^3$, while safe levels set by WHO are <25 $\mu g/m^3$.[44] In Mongolia, children are encouraged to stay indoors when the air quality is at unhealthy and hazardous levels. Hence, it is recommended that parents and kindergartens encourage children to play outside, but only when air pollution levels are safe.

Another explanation for the low levels of physical activity could be a lack of safe and suitable playgrounds for young children within the neighborhoods and kindergartens. A recent review found that availability, convenience, and size of outdoor play spaces were consistently associated with children's physical activity levels.[45] However, in the last 30 years of rapid urbanization, the city of Ulaanbaatar has become overcrowded with buildings built haphazardly and major issues with urban planning.[46] Consequently, there is a lack of recreational parks and children's play areas, as well as weak controls over playground equipment safety.[47,48] Parents refrain from allowing their children to play outside as children's injury rates due to unsafe playgrounds have been on the increase, not only in the capital city, but nationwide. Finally, the low levels of physical activity may partially explain the high level of sedentary screen time among surveyed preschoolers due to the codependent nature of the 24-hour movement behaviors.

Parent-reported sleep durations were similar to Vietnam,[21] Zimbabwe,[22] Japan,[39] and other Western countries[10,40] but were markedly higher than those from China[12] and Hong Kong.[18] Variations in sleep times might be attributed to the measurement method. Studies from China and Hong Kong used objective accelerometer measurements, whereas in our study, sleep duration was reported by parents, which tends to be overestimated.[49] Our results confirm the findings of Mindell et al[50] that although children from Asian countries have shorter night-time sleep compared to children from Western countries, they have longer daytime naps (for over 90 min), making total sleep time in 24 hours similar across cultures.

Consistent with our results, studies have reported differences in physical activity by sex in young children, with boys more active than girls.[42,45,51] Sex differences in playing styles can partly explain these differences.[52] Boys were observed to engage in more rough and tumble play, including more physical contact. Girls may receive less support and lower expectations from parents and teachers to be active.[53] Mongolian nomadic culture required boys to be more physically active and athletic from an early age by herding livestock, riding horses, and hunting.[54] At the same time, girls were expected to stay at home and do housework with other women in the family. Although more than half the population now live in urban areas, cultural values may still exist in families, which can be expressed by parents' expectation that young boys will engage in more physically active play and become "strong men" while girls are expected to be quiet and humble.

Association of Movement Behaviors With Health Indicators

Our findings align with the existing literature, highlighting the positive relationships between the WHO movement guidelines' compliance (individually or in combination) and health indicators in children. Children meeting individual and combination of physical activity and sleep guidelines demonstrated better motor skill development, aligning with similar studies' results.[11]

We found that more time engaging in total physical activity and MVPA was favorably associated with fundamental motor skills, consistent with the literature in the field.[13,55] This finding may indicate that children with better motor skill competence tend to be more physically active.[56] Encouragement and promotion of physical activity are needed to support motor skill development among preschool children. Kindergartens are an important setting to encourage and develop healthy movement behaviors in the early years,[57] as Mongolian preschoolers spend an average of 8 hours every weekday in these settings. Future research is recommended to assess the current curriculum of classroom activities in public and private kindergartens in Mongolia and to explore opportunities to engage children in greater amounts of physical activity to support their health and development.

One unexpected result was that more screen time was favorably associated with better mobility and upper body strength assessment scores. In contrast to our results, a prospective observational study reported the adverse effect of excessive screen time on manual dexterity; however, no relationship was detected between screen viewing behavior and gross motor development.[56] These inconsistent findings indicate that it may be too early to detect any potential negative connections between prolonged screen time and motor development in preschool children. Larger and more representative samples are necessary to confirm the results, as this study had a small convenience sample. Furthermore, current studies reveal that in addition to the duration of screen time, other factors such as quality of content, parental involvement, and the type (active or passive) of screen-based activities are critical to health outcomes.[58,59] Future research should; therefore, consider these factors in order to understand the nature of this relationship better.

Feasibility of the SUNRISE Protocol

Establishing good relationships with kindergartens and parents was an important factor in the efficient data collection procedure and high adherence to the accelerometer protocol with minimal invalid data. Since public kindergartens in Mongolia fall under the Ministry of Education and Science jurisdiction, we asked for support from the officers in charge of preprimary education in our initial contact with the management of the participating kindergartens. Teachers' engagement was also crucial in all stages of data collection, including dissemination of information to parents, recruitment of participants, and conducting assessments and measurements. As parents knew the teachers and trusted them, it was more efficient to communicate with parents in the presence of teachers. Additionally, teachers facilitated monitoring accelerometer wear time during weekdays when children attended kindergarten to ensure that participants wore them correctly and consistently.

Limitations

Several limitations should be considered when interpreting the results of this study. First, this study was conducted as a pilot study to explore initial trends and feasibility. As such, the sample size was intentionally small, limiting the generalizability of the findings to a broader population. Additionally, the study utilized

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

convenience sampling to recruit participants, which introduces the potential for selection bias and reduces the sample's representativeness. Another notable limitation is the categorization of a kindergarten located in Ulaanbaatar city's outskirt suburb, Dambadarjaa, as proxy of rural setting within this area. Therefore, results on urban–rural differences need to be interpreted with caution. Future research with larger and representative sample would be essential to draw more robust conclusions.

Conclusions

Our study provided initial data on 24-hour movement behaviors among Mongolian preschool-aged children. Only a small proportion of children meet the WHO recommendations. Screen time was the behavior with the lowest adherence level. Meeting the guidelines was favorably associated with health indicators in preschool children. Overall, the results of the present study will help inform the SUNRISE Mongolia main study and lay the groundwork for future research into children's 24-hour movement behaviors in Mongolia.

Acknowledgments

The authors are grateful to all participating children, parents, and kindergarten staff. The authors would like to thank researchers of the Nutrition Department at the National Center for Public Health of Mongolia and officers at the Ministry of Education and Science for their support in data collection. The authors also would like to thank the SUNRISE Coordinating Center at Early Start, University of Wollongong, for their support and coordination. Study data were collected and managed using REDCap electronic data capture tools hosted at the University of Wollongong. **Funding Source**: Ankhmaa Byambaa is funded by the Australia Awards Mongolia scholarship program. Research reported in this work was partly funded by the University of Wollongong, Australia, and a Canadian Institutes of Health Research Planning and Dissemination Grant number 392396. The views presented in this work are solely the responsibility of the author(s) and do not necessarily represent the views of the University of Wollongong or the Australian Government.

References

1. World Health Organization. Obesity and overweight. 2022. Accessed August 15, 2022. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
2. Di Cesare M, Sorić M, Bovet P, et al. The epidemiological burden of obesity in childhood: a worldwide epidemic requiring urgent action. *BMC Med*. 2019;17(1):1–20. doi:10.1186/s12916-019-1449-8
3. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev*. 2004;5:4–85. doi:10.1111/j.1467-789X.2004.00133.x
4. Peeters A, Barendregt JJ, Willekens F, et al. Obesity in adulthood and its consequences for life expectancy: a life-table analysis. *Ann Intern Med*. 2003;138(1):24–32. doi:10.7326/0003-4819-138-1-200301070-00008
5. Okely T, Reilly JJ, Tremblay MS, et al. Cross-sectional examination of 24-hour movement behaviours among 3- and 4-year-old children in urban and rural settings in low-income, middle-income and high-income countries: The SUNRISE study protocol. *BMJ Open*. 2021;11(10):e049267. doi:10.1136/bmjopen-2021-049267
6. Okely AD, Ghersi D, Hesketh KD, et al. A collaborative approach to adopting/adapting guidelines—The Australian 24-hour movement guidelines for the early years (Birth to 5 years): an integration of physical activity, sedentary behavior, and sleep. *BMC Public Health*. 2017;17(suppl 5):869. doi:10.1186/s12889-017-4867-6
7. Chaput J-P, Carson V, Gray C, Tremblay M. Importance of all movement behaviors in a 24 hour period for overall health. *Int J Environ Res Public Health*. 2014;11(12):12575–12581. doi:10.3390/ijerph111212575
8. World Health Organization. *Guidelines on Physical Activity, Sedentary Behaviour and Sleep for Children Under 5 Years of Age*. 2019.
9. Rollo S, Antsygina O, Tremblay MS. The whole day matters: understanding 24-hour movement guideline adherence and relationships with health indicators across the lifespan. *J Sport Health Sci*. 2020;9(6):493–510. doi:10.1016/j.jshs.2020.07.004
10. Cliff DP, McNeill J, Vella SA, et al. Adherence to 24-hour movement guidelines for the early years and associations with social-cognitive development among Australian preschool children. *BMC Public Health*. 2017;17(5):207–215. doi:10.1186/s12889-017-4858-7
11. Kuzik N, Poitras VJ, Tremblay MS, Lee EY, Hunter S, Carson V. Systematic review of the relationships between combinations of movement behaviours and health indicators in the early years (0-4 years). *BMC Public Health*. 2017;17(5):109–122. doi:10.1186/s12889-017-4851-1
12. Guan H, Zhang Z, Wang B, et al. Proportion of kindergarten children meeting the WHO guidelines on physical activity, sedentary behaviour and sleep and associations with adiposity in urban Beijing. *BMC Pediatr*. 2020;20(1):1969. doi:10.1186/s12887-020-1969-6.
13. Carson V, Lee EY, Hewitt L, et al. Systematic review of the relationships between physical activity and health indicators in the early years (0-4 years). *BMC Public Health*. 2017;17(5):33–63. doi:10.1186/s12889-017-4860-0
14. Tremblay MS, Chaput JP, Adamo KB, et al. Canadian 24-hour movement guidelines for the early years (0–4 years): an integration of physical activity, sedentary behaviour, and sleep. *BMC Public Health*. 2017;17(5):4859. doi:10.1186/s12889-017-4859-6
15. Draper CE, Tomaz SA, Biersteker L, et al. The South African 24-hour movement guidelines for birth to 5 years: an integration of physical activity, sitting behavior, screen time, and sleep. *J Phys Act Health*. 2020;17(1):109–119. doi:10.1123/jpah.2019-0187
16. Loo BKG, Okely A, Taylor R, et al. Asia–Pacific consensus statement on integrated 24-hour activity guidelines for the early years. *Lancet Reg Health West Pac*. 2022;32:100641. doi:10.1016/j.lanwpc.2022.100641
17. Tapia-Serrano MA, Sevil-Serrano J, Sánchez-Miguel PA, López-Gil JF, Tremblay MS, García-Hermoso A. Prevalence of meeting 24-hour movement guidelines from pre-school to adolescence: a systematic review and meta-analysis including 387,437 participants and 23 countries. *J Sport Health Sci*. 2022;11:427–437 doi:10.1016/j.jshs.2022.01.005
18. Feng J, Huang WY, Reilly JJ, Wong SHS. Compliance with the WHO 24-h movement guidelines and associations with body weight status among preschool children in Hong Kong. *Appl Physiol Nutr Metab*. 2021;46(10):1273–1278. doi:10.1139/apnm-2020-1035
19. Hossain MS, Deeba IM, Hasan M, et al. International study of 24-h movement behaviors of early years (SUNRISE): a pilot study from Bangladesh. *Pilot Feasibility Stud*. 2021;7(1):912. doi:10.1186/s40814-021-00912-1
20. Tanaka C, Okada S, Takakura M, et al. Relationship between adherence to WHO "24-hour movement guidelines for the early

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

years" and motor skills or cognitive function in preschool children: SUNRISE pilot study. *Jpn J Phys Fit Sports Med*. 2020;69:327–333. doi:10.7600/JSPFSM.69.327
21. Kim TV, Pham TN, Nguyen CL, Nguyen TT, Okely AD, Tang HK. Prevalence of physical activity, screen time, and sleep, and associations with adiposity and motor development among preschool-age children in Vietnam: The SUNRISE Vietnam pilot study. *Ind J Pediatr*. 2022;89(2):148–153. doi:10.1007/s12098-021-03895-2
22. Munambah N, Gretschel P, Muchirahondo FC, et al. 24 hour movement behaviours and the health and development of pre-school children from Zimbabwean settings: The SUNRISE pilot study. *S Afr J Sports Med*. 2021;33(1):v33i1a10864. doi:10.17159/2078-516X/2021/v33i1a10864
23. Draper C, Tomaz SA, Cook CJ, et al. Understanding the influence of 24-hour movement behaviours on the health and development of preschool children from low-income South African settings: The SUNRISE pilot study. *S Afr J Sports Med*. 2020;32(1):415. doi:10.17159/2078-516X/2020/v32i1a8415
24. Delisle Nyström C, Alexandrou C, Henström M, et al. International study of movement behaviors in the early years (Sunrise): results from sunrise Sweden's pilot and covid-19 study. *Int J Environ Res Public Health*. 2020;17(22):8491. doi:10.3390/ijerph17228491
25. National Statistics Office of Mongolia. Population statistics by age, sex and age group. 2022. Accessed January 4, 2023. https://1212.mn/mn/statistic/statcate/573051/table-view/DT_NSO_0300_071V3
26. Ministry of Education and Science. "Policy and actions to support holistic development of young children". 2023. Accessed October 26, 2023. https://www.meds.gov.mn/post/125521
27. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inf*. 2009;42(2):377–381. doi:10.1016/j.jbi.2008.08.010
28. World Health Organization. *WHO Child Growth Standards: Training Course on Child growth Assessment*. 2008.
29. World Health Organization. WHO child growth standards. 2006. https://www.who.int/tools/child-growth-standards
30. World Health Organization. WHO growth chart for children 5–19 years. 2007. https://www.who.int/tools/growth-reference-data-for-5to19-years
31. Bingham DD, Costa S, Clemes SA, Routen AC, Moore HJ, Barber SE. Accelerometer data requirements for reliable estimation of habitual physical activity and sedentary time of children during the early years—a worked example following a stepped approach. *J Sports Sci*. 2016;34(20):2005–2010. doi:10.1080/02640414.2016.1149605
32. Cliff DP, Reilly JJ, Okely AD. Methodological considerations in using accelerometers to assess habitual physical activity in children aged 0–5 years. *J Sci Med Sport*. 2009;12(5):557–567. doi:10.1016/j.jsams.2008.10.008
33. Pate RR, O'Neill JR, Brown WH, Pfeiffer KA, Dowda M, Addy CL. Prevalence of compliance with a new physical activity guideline for preschool-age children. *Child Obes*. 2015;11(4):415–420. doi:10.1089/chi.2014.0143
34. Pate RR, Almeida MJ, McIver KL, Pfeiffer KA, Dowda M. Validation and calibration of an accelerometer in preschool children. *Obesity*. 2006;14(11):2000–2006. doi:10.1038/oby.2006.234
35. Howard SJ, Melhuish E. An early years toolbox for assessing early executive function, language, self-regulation, and social development: validity, reliability, and preliminary norms. *J Psychoeduc Assess*. 2017;35(3):255–275. doi:10.1177/0734282916633009
36. Reuben DB, Magasi S, McCreath HE, et al. Motor assessment using the NIH Toolbox. *Neurology*. 2013;80(11 suppl 3):S65–S75.
37. The Jamovi Project. Version 2.2.5. 2022. https://www.jamovi.org
38. Braun V, Clarke V.Thematic analysis. *APA Handbook of Research Methods in Psychology, Vol 2: Research Designs: Quantitative, Qualitative, Neuropsychological, and Biological*. American Psychological Association; 2012:57–71.
39. Tanaka C, Okada S, Takakura M, et al. Relationship between adherence to WHO "24-hour movement guidelines for the early years" and motor skills or cognitive function in preschool children: sunrise pilot study. *Jpn J Phys Fitness Sports Med*. 2020;69(4):327–333. doi:10.7600/jspfsm.69.327
40. Chaput JP, Colley RC, Aubert S, et al. Proportion of preschool-aged children meeting the Canadian 24-hour movement guidelines and associations with adiposity: results from the Canadian Health Measures Survey. *BMC Public Health*. 2017;17(5):147–154.
41. National Statistics Office of Mongolia. Multiple indicator cluster survey report 2020–2021. 2022. Accessed May 28, 2023. www.1212.mn/surveymn.aspx
42. Hinkley T, Crawford D, Salmon J, Okely AD, Hesketh K. Preschool children and physical activity: a review of correlates. *Am J Prev Med*. 2008;34(5):435–441.e7. doi:10.1016/j.amepre.2008.02.001
43. Carson V, Spence JC, Cutumisu N, Boule N, Edwards J. Seasonal variation in physical activity among preschool children in a northern Canadian city. *Res Q Exerc Sport*. 2010;81(4):392–399. doi:10.1080/02701367.2010.10599699
44. World Health Organization. Air pollution in Mongolia. *Bull World Health Organ*. 2019;97(2):79–80. doi:10.2471/BLT.19.020219
45. Arts J, Drotos E, Singh AS, Chinapaw MJ, Altenburg TM, Gubbels JS. Correlates of physical activity in 0-to 5-year-olds: a systematic umbrella review and consultation of international researchers. *Sports Med*. 2023;53(1):215–240. doi:10.1007/s40279-022-01761-5
46. Baasantogtokh O. Ulaanbaatar city: urbanization issues. *Proc Mong Acad Sci*. 2013;2013:51–60.
47. Batsukh O, Oyunchimeg N. Parents rally for child-friendly spaces. Global Press Journal. 2022. Accessed March 18, 2023. https://globalpressjournal.com/asia/mongolia/parents-rally-child-friendly-spaces/
48. Center for Health Development of Mongolia. Accidents and injury report, 2021. 2021. Accessed March 16, 2023. http://hdc.gov.mn/media/uploads/2022-04/OG-tailan.pdf
49. Dayyat EA, Spruyt K, Molfese DL, Gozal D. Sleep estimates in children: parental versus actigraphic assessments. *Nat Sci Sleep*. 2011;3:115–123. doi:10.2147/nss.s25676
50. Mindell JA, Sadeh A, Kwon R, Goh DY. Cross-cultural differences in the sleep of preschool children. *Sleep Med*. 2013;14(12):1283–1289. doi:10.1016/j.sleep.2013.09.002
51. Tucker P. The physical activity levels of preschool-aged children: a systematic review. *Early Child Res Q*. 2008;23(4):547–558. doi:10.1016/j.ecresq.2008.08.005
52. DiPietro JA. Rough and tumble play: a function of gender. *Dev Psychol*. 1981;17(1):50–58. doi:10.1037/0012-1649.17.1.50
53. Pate RR, Pfeiffer KA, Trost SG, Ziegler P, Dowda M. Physical activity among children attending preschools. *Pediatrics*. 2004;114(5):1258–1263. doi:10.1542/peds.2003-1088-L
54. West A. A child protection system in Mongolia. Ulaanbaatar: Save the Children UK Mongolian Office. 2006.
55. Veldman SLC, Chin A Paw MJM, Altenburg TM. Physical activity and prospective associations with indicators of health and development in children aged <5 years: a systematic review. *Int J Behav Nutr Phys Act*. 2021;18(1):1072. doi:10.1186/s12966-020-01072-w

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC

56. Webster EK, Martin CK, Staiano AE. Fundamental motor skills, screen-time, and physical activity in preschoolers. *J Sport Health Sci*. 2019;8(2):114–121. doi:10.1016/j.jshs.2018.11.006
57. Jones RA, Sousa-Sá E, Peden M, Okely AD. Childcare physical activity interventions: a discussion of similarities and differences and trends, issues, and recommendations. *Int J Environ Res Public Health*. 2019;16(23):4836. doi:10.3390/ijerph16234836
58. Chu S, Hale S. Letter in response to 'The good, the bad and the ugly of children's screen time during the COVID-19 pandemic'. *Acta Paediatr*. 2022;111(1):183. doi:10.1111/apa.16102
59. Beatty C, Egan SM. Screen time in early childhood: a review of prevalence, evidence and guidelines. *An Leanhb Óg*. 2020;13(1): 17–31.

Unauthenticated | Downloaded 05/19/25 08:05 AM UTC