



Original research

Associations between meeting the Canadian 24-Hour Movement Guidelines for the Early Years and behavioral and emotional problems among 3-year-olds



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ABSTRACT

Objectives: Primary: examine associations between meeting the 24-Hour Movement Guidelines for the Early Years and behavioral and emotional problems in a large sample of 3-year-old children. Secondary: determine the proportion of children meeting the Canadian 24-Hour Movement Guidelines.

Design: Cross-sectional.

Methods: Participants were 3-year olds (n = 539) from the Edmonton site of the Canadian Healthy Infant Longitudinal Development (CHILD) birth cohort. Physical activity and sleep duration were accelerometer-derived while screen time was parent-reported. Meeting the overall guidelines was defined as: (1) ≥ 180 min/day of total physical activity, including 60 min/day of moderate- to vigorous-intensity physical activity, (2) ≤ 1 h/day of screen time, and (3) 10–13 h of sleep per 24-hour period. Externalizing, internalizing, and total problem scores (lower scores representing fewer problems) were calculated from the parent-reported Child Behavior Checklist (CBCL). Descriptive statistics and linear regression models were completed.

Results: Only 5% of children met the overall guidelines (all three recommendations), with 19.3%, 50.5%, and 83.1% meeting the physical activity, screen time, and sleep recommendations, respectively. Meeting more recommendations was associated with lower scores for total (B = -1.78, 95%CI: -3.03, -0.54), externalizing (B = -1.51, 95%CI: -2.80, -0.22) and internalizing (B = -1.35, 95%CI: -2.60, -0.01) problems. Similar findings were also observed for the specific combinations of: (1) physical activity and screen time and (2) sleep duration and screen time.

Conclusions: Meeting more recommendations within the 24-hour Movement Guidelines was associated with fewer behavioral and emotional problems at 3-years. Few 3-year-olds met the overall guidelines. Findings support an integrated approach for healthy growth and development.

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Practical implications

- Meeting more recommendations was associated with fewer behavioral and emotional problems, as measured by the CBCL.
- Associations were most evident for combinations of sleep/screen time and physical activity/screen time.
- Associations were strongest for total and externalizing problems.
- Few children met the new 24-Hour Movement Guidelines for the Early Years.

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1. Introduction

Physical activity, sedentary behavior, and sleep are three co-dependent movement behaviors that cover the full range of movement in a 24-hour period. Recent systematic reviews suggest that more physical activity, less sedentary behavior, and adequate sleep in children during the early years (0–4 years) are associated with immediate and long-term health benefits for growth and development.^{1–4} However, as highlighted in these reviews, movement behaviors have traditionally been studied and promoted separately. One systematic review on the associations between combinations of movement behaviors and health indicators only found ten studies in children of the early years.³ None of these studies included all three movement behaviors and almost all studies focused on adiposity.³

Recognizing the importance of an integrated movement behavior approach for promoting healthy growth and development, Australia, Canada, and New Zealand each recently released 24-Hour Movement Guidelines for the Early Years.^{5–7} The development of the Canadian guidelines followed a rigorous process and the guidelines were informed by four systematic reviews, compositional analyses, expert consensus, stakeholder feedback, and methodological advice.⁵ Australia adopted the Canadian guidelines following an established approach.⁶ Additional studies looking at the associations of combinations of physical activity, sedentary behavior, and sleep with health indicators were conducted as part of this work.^{8–13} However, only one study examined associations with social-cognitive development,¹⁰ with the rest focusing on adiposity.^{9,11–13} Research that includes other domains of growth and development is recommended.^{8,12}

Early life behavioral and emotional problems, such as externalizing (e.g., aggressive), internalizing (e.g., social withdrawal) problems, often continue into later childhood and beyond.¹⁴ Social and emotional domains of growth and development have received limited focus when examining the combined impact of movement behaviors.³ The primary objective of this study was to examine the associations of meeting different combinations of recommendations within the Canadian 24-Hour Movement Guidelines for the Early Years and behavioral and emotional problems at 3-years of age. The secondary objective was to determine the proportion of 3-year old children meeting different combinations of recommendations within the Canadian 24-Hour Movement Guidelines for the Early Years. We hypothesized that children meeting more recommendations within the guidelines would have fewer behavioral and emotional problems and that only a small percentage of children would meet the overall 24-Hour Movement Guidelines.

2. Methods

Participants for this cross-sectional study were a subset of parents and their 3-year old children from the Edmonton site of the Canadian Healthy Infant Longitudinal Development (CHILD) Study (www.childstudy.ca). Overall, 3455 families from the general population participated in CHILD, a multi-site birth cohort that recruited during pregnancy between 2008 and 2012 from four locations across Canada (Edmonton, Toronto, Vancouver and Manitoba (Winnipeg with two surrounding rural communities)). Data collection occurred at multiple time points including pregnancy and when the child was 3, 6, 12, 18, 24, 30 months, 3, 4, and 5 years. Specific details on CHILD recruitment, inclusion/exclusion criteria, and data collection procedures can be found elsewhere.^{15,16} At the Edmonton site, which enrolled 805 eligible families, participants completed a series of CHILD Study questionnaires and assessments at the 3-year clinic visit. A sub-set of 520 participants were given an accelerometer for the child to wear and an accompanying accelerometer log

book. This number was determined by the availability of devices. Edmonton was the only CHILD site that included accelerometer measures at age 3 years. Ethics approval for the CHILD Edmonton site was obtained from the University of Alberta Human Research Ethics Board and informed written consent was obtained from all participating families.

As part of the development of the 24-Hour Movement Guidelines, a sub-committee provided definitions for surveillance of the guidelines.⁵ Specifically, for preschoolers (3–4 years), meeting the overall 24-Hour Movement Guidelines involves meeting three recommendations: (1) At least 180 min per day of total physical activity, with at least 60 min per day of moderate- to vigorous-intensity physical activity (MVPA), (2) no more than 1 h per day of screen time, and (3) 10–13 h of sleep within a 24-hour period.⁵ Details on the measurement of each movement behavior at the CHILD Edmonton site are outlined below.

Physical activity and sleep duration were objectively-measured with wrist-worn Actigraph GT3X-BT accelerometers (ActiGraph Corp, Pensacola, FL, USA). Parents were instructed to have their child wear the accelerometer on their non-dominant wrist for seven consecutive 24-hour periods. Data were collected in 60-second epochs using a 30Hz sampling frequency. Sleep during the day (i.e., naps) and night for each 24-hour period was determined via visual inspection of sleep analysis graphs using Actilife[®] software with the support of the log books. For data classified as wake time, non-wear time was defined as ≥ 20 min of consecutive zeros counts.¹⁷ A valid day of wake time was defined as ≥ 10 h of wear time. Days and the corresponding periods of day and night sleep were deleted for invalid days of wake time. Participants were excluded from the analyses if they did not have any valid days of wake time.¹⁸ Compared to the waist placement site, few studies have validated wrist-worn accelerometer cut-points in children.¹⁹ In line with a previous study in pre-school children,²⁰ light-intensity physical activity (LPA) was defined as 3660–9816 vector magnitude counts per minute and MVPA as >9816 vector magnitude counts per minute, for valid wake time data.²¹ Minutes per day of sleep duration, LPA, MVPA, and total physical activity (LPA+MVPA) were calculated by dividing the number of 60-second intervals of sleep duration, LPA, MVPA, and total physical activity by the total number of valid days. Screen time was measured via parent-report using the following open-ended question: “On average, how many hours per day does your child sit and watch TV/DVDs, use a computer/tablet/ipod/iphone, or play video games?”.

Behavioral and emotional problems were measured at the CHILD Edmonton site only by parent-report using the Child Behavior Checklist (CBCL) for ages 1.5–5 years.²² This standardized tool includes 99 items with three response options including, “not true (as far as you know)”, “somewhat or sometimes true”, and “very true or often true” in relation to the child now or within the past 2 months. A standardized score was calculated based on normative data for externalizing (i.e., aggressive and destructive), internalizing (i.e., social withdrawal, depressed), and total problems (i.e., externalizing, internalizing, sleep problems).²² Significant one-week test-retest reliability ($r=0.87$; $p<0.001$) and significant one-year stability ($r=0.69$, $p<0.001$) have been previously reported for the CBCL.²² Additionally, in terms of discriminative validity, children referred for mental health services have been found to have significantly higher scores than children from the general population.²²

Informed by previous research,^{1–4} child sex, child ethnicity, maternal education, household income, parental marital status, maternal depression, and parent-child relationship quality were included as covariates in the analyses. All covariates were measured by parent-report. Child ethnicity was determined by maternal and paternal ethnicity and was categorized into two groups (Caucasian;

other). The highest education level achieved by the child's mother (completed post-secondary education; has not completed post-secondary education), household income (<\$60,000; ≥\$60,000 per year), and parental marital status (married/common law; separated/divorced/widowed/single) were each categorized into two groups. Maternal depression was measured with the 20-item Center for Epidemiological Studies–Depression (CES-D) tool,²³ with higher scores indicating greater depressive symptoms. Parent-child relationship quality was measured with the 12-item parent-child dysfunctional interaction (P-CDI) tool, with higher scores indicating lower quality relationships.²⁴

Statistical analyses were completed using SAS version 9.4 (SAS Institute Inc., Cary, NC). Differences between samples of participants: (1) with and without behavioral and emotional problems and (2) with and without movement behavior data were examined using chi-squared statistics and t-tests or wilcoxon two-sample tests. Descriptive statistics for the proportion of participants meeting different combinations of recommendations were conducted in the sample of participants with complete movement behavior data. Linear regression models were completed to examine the association between meeting and not meeting individual recommendations (i.e., physical activity, screen time, sleep), specific combinations of recommendations, (i.e., physical activity and screen time, physical activity and sleep, screen time and sleep) and general combinations of recommendations (i.e., three, two, one, none) with behavioral and emotional problems. The unstandardized beta coefficients can be interpreted as the number of units higher or lower on the CBCL when moving from the reference group to the non-reference group. A trend analysis was conducted for specific and general combinations of recommendations by including the ordinal recommendation variable in the model. The unstandardized beta coefficients can be interpreted as the number of units higher or lower on the CBCL for every additional recommendation met. This analysis was completed to examine whether there was a gradient of meeting more recommendations with fewer or greater behavioral and emotional problems. Separate models were run for total, externalizing, and internalizing problems. All regression models were conducted in the sample of participants with complete behavioral and emotional problems data. Missing values for movement behavior variables and covariates were replaced with the sample mean (continuous) or reference (categorical) value, and dummy variables were created for each variable with missing data (e.g., 0 = data available; 1 = data missing). All models were adjusted for child sex, child ethnicity, maternal education, household income, parental marital status, maternal depression, parent-child interaction quality, and dummy missingness variables. Statistical significance was defined as $p < 0.05$.

3. Results

Participant characteristics are shown in Table 1. Of the 805 eligible CHILd Edmonton participants, two were excluded because of a diagnosed developmental or genetic disorder, leaving an eligible sample of 803. Of these, 539 had data for behavioral and emotional problems. A significantly higher percentage of participants with outcome data were classified in the following groups for child and maternal characteristics compared to those without outcome data: Caucasian, married/common law, completed post-secondary education, and household income ≥\$60,000. Furthermore, participants with outcome data had significantly lower maternal depression scores. Of the eligible 520 participants who received an accelerometer, 138 had either no data (i.e., lost the monitor, device malfunction) or invalid accelerometer data (i.e., <1 day of valid wake time), and an additional 39 were missing screen time data, leaving a sample of 343 participants. A signifi-

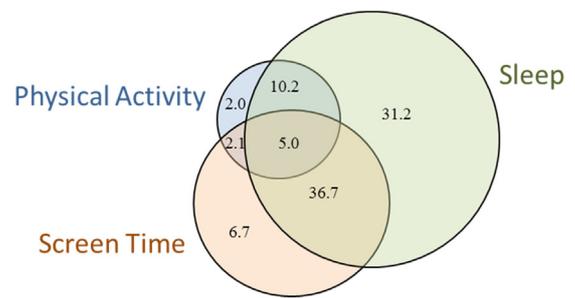


Fig. 1. Venn diagram for the proportion of participants meeting the 24-Hour Movement Guidelines for the Early Years and combinations of recommendations within the guidelines ($n = 343$). Circle size is proportional to the proportion meeting the recommendation. A total of 6.1% of participants met none of the recommendations.

cantly higher percentage of participants with exposure data were classified in the following groups for child and maternal characteristics compared to those without exposure data: completed post-secondary education and household income of ≥\$60,000.

Of the 343 participants with data for movement behaviors, the average number of valid days was 4.4 (± 1.9) and the average valid awake wear time was 12.7 (± 1.0) hours/day. The highest percentage of participants met the sleep recommendation, (83.1%; Fig. 1), followed by screen time (50.5%), and then physical activity (19.3%) recommendations. Additionally, 41.7% met both sleep and screen time recommendations, 15.2% met both physical activity and sleep recommendations, and only 7.1% met both physical activity and screen time recommendations. A total of 5% of participants met the overall guidelines (all three recommendations) and just over 6% met none of the recommendations.

Children not meeting the screen time recommendation had a significantly higher total problem score ($B = 3.04$, 95% Confidence Interval (CI): 1.45, 4.63; Table 2), externalizing score ($B = 2.72$, 95%CI: 1.08, 4.37), and internalizing score ($B = 1.94$, 95%CI: 0.28, 3.60) as compared to those children meeting the screen time recommendations. No significant associations were observed between physical activity and sleep recommendations and CBCL scores.

There was a significant trend that meeting more recommendations for the combination of physical activity and screen time was associated with a lower score for total problems ($B = -2.19$, 95%CI: -3.56 , -0.81), externalizing problems ($B = -1.84$, 95%CI: -3.27 , -0.42), and internalizing problems ($B = -1.97$, 95%CI: -3.40 , -0.54). A similar pattern was seen for the combination of screen time and sleep. No significant association was observed between the combination of physical activity and sleep and CBCL scores.

For general combinations of recommendations, there was also a significant trend that meeting more recommendations was associated with lower score for total problems ($B = -1.78$, 95%CI: -3.03 , -0.54), externalizing problems ($B = -1.51$, 95%CI: -2.80 , -0.22), and internalizing problems ($B = -1.35$, 95%CI: -2.60 , -0.01). Children meeting none or only one recommendation had a 2.02 point higher total problem score (95%CI: 0.47, 3.58) compared to children meeting two or three recommendations. A similar pattern was observed for externalizing problems ($B = 1.71$, 95%CI: 0.10, 3.33).

4. Discussion

This study used a relatively large sample of 3-year-olds with objective measures of physical activity and sleep to examine the proportion meeting new 24-Hour Movement Guidelines, and associations between meeting the guidelines and emotional and behavioral problems. Children meeting more recommendations within the guidelines had lower behavioral and emotional problems as measured by the CBCL. This pattern was particularly evident for specific combinations of physical activity and screen time, and

Table 1
Participant characteristics for those with and without behavioral and emotional problems (outcome) data and with and without movement behavior (exposure) data.

Variables	n	Outcome data present	n	Outcome data not present	p-Value	n	Exposure data present	n	Exposure data not present	p-Value
Demographic										
Child sex (%)	539		264		0.384	343		460		0.655
Male		52.1		48.9			50.1		51.7	
Female		47.9		51.1			49.9		48.3	
Child ethnicity (%)	528		245		0.002	341		432		0.066
Caucasian		71.4		60.0			71.3		65.0	
Other		28.6		40.0			28.7		35.0	
Mother's education (%)	519		243		<0.001	332		430		0.008
Completed post-secondary education		80.0		63.8			79.5		71.2	
Did not complete post-secondary education		20.0		36.2			20.5		28.8	
Household income (%)	527		231		<0.001	340		418		<0.001
≥\$60,000		93.9		77.9			6.8		14.3	
<\$60,000		6.1		22.1			93.2		85.7	
Parental marital status (%)	520		243		0.043	331		432		0.189
Married/common law		93.8		89.7			8.6		6.0	
Separated/divorced/widowed/single		6.2		10.3			91.4		94.0	
Maternal depression	445	10.7 (7.4)	67	13.8 (9.6)	0.014	313	11.0 (7.7)	199	11.2 (7.8)	0.741
Parent-child relationship quality	442	16.2 (4.8)	63	17.0 (5.7)	0.229	308	16.0 (4.9)	197	16.5 (5.0)	0.320
Movement behaviors										
Total physical activity (min/day)	337	389.9 (3.8)	45	370.4 (12.9)	0.154					–
MVPA (min/day)	337	43.5 (23.2)	45	39.8 (25.4)	0.326					–
Sleep (h/24-hour period)	337	11.0 (1.1)	45	10.9 (1.3)	0.375					–
Screen time (h/day)	449	1.7 (1.2)	87	1.8 (1.2)	0.488					–
Behavioral and emotional problems										
Total problems	539	45.5 (9.2)	264	–		238	45.1 (9.4)	301	45.6 (9.1)	0.529
Internalizing problems		44.5 (9.3)		–			46.2 (9.4)		45.8 (9.4)	0.660
Externalizing problems		46.0 (9.5)		–			44.7 (9.2)		44.7 (9.3)	0.999

MVPA = moderate- to vigorous-intensity physical activity.

Categorical variables presented as percentages and continuous variables presented as mean (standard deviation).

p < 0.05.

screen time and sleep. However, the overall effect size for observed associations was small. Additionally, a very small percentage of children met the overall guidelines.

Certain health indicators may be more sensitive to integrated movement behaviors than others. The present study makes an important contribution to the literature by including measures of social and emotional development. Most studies examining the association between meeting the new 24-Hour Movement Guidelines and health indicators have focused on the physical domain and in particular adiposity.^{9,11–13} No associations between meeting the guidelines and adiposity were observed in these studies.^{9,11–13} Conversely, in line with the current study, the one study that included a measure of social-cognitive development found that children who met more recommendations within the guidelines had better social cognition and Theory of Mind.¹⁰ This association was most evident when looking at the specific combinations of sleep and physical activity and sleep and screen time.¹⁰ Future research is needed in social, emotional, and cognitive domains of growth and development in this age group.

Several new studies were conducted to determine the proportion of children meeting the new 24-Hour Movement Guidelines in Australia and Canada. Two of these studies were conducted in pre-school children, one in a representative sample of Canadian pre-school children⁹ and the other in a regional sample of Australian pre-school children.¹⁰ The proportion of children meeting the overall guidelines was lower in the present sample (5%) when compared to these two previous studies (12.7–14.9%).^{9,10} A similar proportion of children met the sleep recommendations (83.9–88.7%) in these studies.^{9,10} Objectively-measured sleep was only included in the current study. The proportion of children meeting the screen time recommendation was higher in the present study (51.7%) when compared to the previous studies (17.3–24.4%).^{9,10} Therefore, the physical activity recommendation is driving the lower percentage meeting the overall guideline in

the present study. The proportion of children meeting the physical activity recommendation was much lower in the current sample (19.3%) when compared to previous studies (61.8–93.1%).

Differences in accelerometer data collection and data reduction between studies make comparisons of accelerometer-derived variables such as physical activity challenging.¹⁹ Several differences exist between the present study and previous guideline studies in pre-school children.^{9,10} For example, CHILD participants wore the accelerometers on their wrist and not their hip; vector magnitude counts (i.e., data from three axes) versus vertical axis counts were used for cut-points; and data were collected in 60-second epochs compared to 15-second epochs. A previous study in preschool children found less MVPA is captured and more LPA and total physical activity is captured when using 60-second epochs compared to 15-second epochs.²⁵ These findings could explain why another study in Swedish preschool-children that used similar procedures as the present study (i.e., 24-hour protocol, wrist-worn accelerometers, identical Vector Magnitude cut-points) but 5-second epochs reported higher estimates of MVPA and lower estimates of LPA.²⁰ Together, these findings suggest that the 60-second epochs used in the current study likely resulted in lower levels of MVPA, and therefore a lower percentage of children meeting the physical activity guidelines compared to prior studies. Regardless, when taking an integrative perspective, findings across studies indicate that a low percentage of preschool children meet the overall 24-Hour Movement Guidelines.

The main strengths of this study are the objective measurement of physical activity and sleep duration, and the inclusion of a social and emotional health indicator using a valid and reliable measure. Additionally, models were adjusted for a number of key potential confounders. In terms of limitations, this study was cross-sectional so the temporality of the associations are unknown and causality cannot be inferred. Similar to prior studies, screen time was parent-reported making it susceptible to recall and social

Table 2
Associations of meeting combinations of recommendations within the 24-Hour Movement Guidelines with behavioral and emotional problems (n = 539).

Meeting recommendations	n	Total problems B (95%CI)	p-Value	Externalizing problems B (95%CI)	p-Value	Internalizing problems B (95%CI)	p-value
Individual recommendations							
PA							
Met	66	Reference		Reference		Reference	
Not met	473	-0.22 (-2.53, 2.09)	0.852	-0.55 (-2.93, 1.84)	0.653	1.42 (-0.977, 3.81)	0.245
ST							
Met	225	Reference		Reference		Reference	
Not met	314	3.04 (1.45, 4.63)	<0.001	2.72 (1.08, 4.37)	0.001	1.94 (0.28, 3.60)	0.022
SP							
Met	486	Reference		Reference		Reference	
Not met	53	-0.04 (-2.57, 2.49)	0.975	-0.03 (-2.65, 2.60)	0.984	-1.29 (-3.91, 1.34)	0.337
Specific combinations							
PA and ST	21	Reference		Reference		Reference	
PA or ST	249	1.68 (-2.10, 5.47)	0.382	1.66 (-2.27, 5.59)	0.407	1.32 (-2.61, 5.27)	0.508
None	269	3.98 (0.12, 7.85)	0.044	3.54 (-0.46, 7.56)	0.083	3.44 (-0.57, 7.47)	0.093
P _{trend}		-2.19 (-3.56, -0.81)	0.002	-1.84 (-3.27, -0.42)	0.011	-1.97 (-3.40, -0.54)	0.007
PA and SP	54	Reference		Reference		Reference	
PA or SP	444	-0.32 (-2.85, 2.22)	0.806	-1.19 (-3.80, 1.44)	0.375	1.65 (-0.97, 4.28)	0.217
None	41	-0.19 (-3.73, 3.36)	0.917	-0.36 (-4.03, 3.30)	0.844	0.17 (-3.50, 3.84)	0.926
P _{trend}		-0.17 (-1.64, 1.87)	0.896	0.28 (-1.52, 2.10)	0.755	-0.25 (-2.07, 1.57)	0.787
ST and SP	198	Reference		Reference		Reference	
ST or SP	315	2.31 (0.68, 3.94)	0.006	2.14 (0.45, 3.83)	0.046	0.85 (-0.85, 2.56)	0.326
None	26	4.32 (0.68, 3.94)	0.018	3.76 (0.06, 7.46)	0.013	2.69 (-1.04, 6.43)	0.157
P _{trend}		-2.25 (-3.62, -0.88)	0.001	-2.03 (-3.45, -0.60)	0.005	-1.07 (-2.50, 0.37)	0.145
General combinations							
Two and three	245	Reference		Reference		Reference	
None and one	294	2.02 (0.47, 3.58)	0.011	1.71 (0.10, 3.33)	0.037	1.42 (-0.21, 3.04)	0.087
Three	14	Reference		Reference		Reference	
Two	231	1.62 (-2.95, 6.20)	0.486	0.83 (-3.92, 5.57)	0.733	1.26 (-3.51, 6.03)	0.604
One	273	3.42 (-1.21, 8.05)	0.147	2.35 (-2.45, 7.14)	0.337	2.47 (-2.35, 7.29)	0.314
None	21	5.25 (-0.51, 11.02)	0.074	4.27 (-1.71, 10.25)	0.161	4.22 (-1.79, 10.22)	0.169
P _{trend}		-1.78 (-3.03, -0.54)	0.005	-1.51 (-2.80, -0.22)	0.022	-1.35 (-2.60, -0.01)	0.048

PA = Physical activity; ST = screen time; SP = sleep; B (95%CI) = unstandardized beta coefficients (95% Confidence Intervals); Meeting the recommendations was defined as ≥ 180 min/day of total physical activity, including 60 min/day of moderate- to vigorous-intensity physical activity; ≤ 1 h/day of screen time, and 10–13 h of sleep per 24 h period; All models are adjusted for child sex, child ethnicity, maternal education, household income, parental marital status, maternal depression, parent-child relationship quality, and dummy missingness variables for child ethnicity, maternal education, household income, parental marital status, maternal depression, parent-child relationship quality, screen time (not included in physical activity and sleep duration individual recommendations models), physical activity/sleep duration (not included in screen time individual recommendation model).

p < 0.05.

desirability biases. Although physical activity was objectively-measured, shorter MVPA bouts may not have been captured with the use of 60-second epochs.²⁵ Furthermore, the cut-points used in this study were not validated in preschool children,²¹ however, they do fall in between two validation studies in 1.25–3 year olds²⁶ and 3.5–4.5 year olds,²⁷ and have previously been used in another sample of preschool children.²⁰ Also, only one valid day of accelerometer data was required for inclusion, which may have impacted the reliability of the physical activity and sleep measurements.²⁸ However, on average, participants had 4.5 valid days of data. Additionally, a large proportion of the sample was excluded due to missing data. Therefore, the generalizability of the findings, in particular the descriptive results, may be affected given the demographic differences between included and excluded participants. This study did not include all recommendations within the 24-hour movement guidelines; however, the recommendations included were in line with surveillance definitions proposed by a guideline development sub-committee.⁵ Finally, the sample size in some groups were small, which may have limited the power to detect associations.

5. Conclusions

This study took an integrated movement behavior approach for examining healthy growth and development by building on new 24-Hour Movement Guidelines that have been released in sev-

eral countries around the world. Meeting more recommendations was associated with fewer behavioral and emotional problems, though observed effect sizes were small. Promoting adherence to the guidelines may be one means of reducing adverse behavioral and emotional problems in early life. Few 3-year-old children met the overall guidelines in this sample. Continued efforts are needed to disseminate and activate the new guidelines to promote healthy growth and development in children of the early years.

Conflicts of interest

The authors have no conflicts of interest to disclose.

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in the study design; in the collection, analysis and interpretation of data; in the writing of the manuscript; and in the decision to submit the article for publication.

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