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Sociodemographic Differences in Young Children Meeting 24-Hour Movement Guidelines

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Abstract

BACKGROUND: Little is known about variation in meeting the 24-Hour Movement Guidelines (including physical activity (PA), sleep, and screen-time (ST)) in early childhood. The aim was to evaluate sociodemographic differences in meeting the 24-Hour Movement Guidelines.

METHODS: Parents of 3-4 year old children reported sociodemographic information, and ST. Sleep and PA were measured using accelerometry, and height and weight were objectively measured. The 24-hour Movement Guidelines include daily PA (total PA: 3 hours; including 1 hour of moderate-to-vigorous), sleep (10-13 hours), and ST (1 hour). Meeting guidelines by age, sex, race, poverty level, and weight status were assessed using chi-square and linear regression models.

RESULTS: Of 107 children, 57% were white and 26% lived in households at or below the poverty level. Most children met the PA (91.5%) and sleep (86.9%) guidelines but few met ST (14.0%) or all three (11.3%) guidelines. African American children and children who lived at or below the poverty level were less likely to meet the sleep, ST, and all three guidelines compared to others ($p < 0.01$ for all). There were no other differences.

CONCLUSION: These results suggest future interventions should focus on reducing differences in movement, namely in sleep and ST.

Keywords

physical activity; sedentary behavior; pediatrics; epidemiology

INTRODUCTION

Adequate amounts of screen-time, physical activity (PA), and sleep are all important for children's overall health and preventing excess weight gain in youth.¹⁻³ Each of these behaviors have demonstrated their individual influence on children's development,^{4,5} but their collective influence is still unknown. The collective influence of movement is important to understand as these behaviors all occur within the 24-hour cycle and are

interrelated (e.g. screen-time before bed may influence sleep duration).⁶ Thus, exhibiting an adequate amount of one behavior may influence the amount of the other behaviors.⁷ As of recent, there are no multi-behavior guidelines including screen-time, PA, and sleep for the United States of America (US), though individual guidelines exist.⁸⁻¹¹ In 2017, the Canadian 24-Hour Movement Guidelines for Early Years were created to concurrently address all three behaviors (screen-time, PA, and sleep) within the day and provide guidance for optimizing child health.¹² The 24-Hour Movement Guidelines for Early Years incorporate a collective focus on these behaviors and recommend a similar amount of each behavior compared to the individual US guidelines.

Despite the benefits of these behaviors, few children engage in adequate PA, sleep or appropriate screen-time amounts.¹³ Previous investigations of the 24-Hour Movement Guidelines for Early Years have found differences in toddlers meeting the guidelines by race, age, sex, and household income.¹⁴ These differences are also found in individual guidelines among preschoolers (2-5 years old), as children who were non-white, older children, girls, and children from lower income households met fewer individual guidelines compared to their counterparts.^{15,16} There is limited evidence in preschoolers addressing whether these sociodemographic differences in individual guidelines translate into differences in meeting the 24-Hour Movement Guidelines. Therefore, the purpose of this investigation was to assess sociodemographic differences (i.e. age, sex, race, poverty level, and weight status) in meeting the 24-Hour Movement Guidelines for Early Years in preschoolers.

METHODS

Participants

This study was an examination of data from “Pause & Play,” a prospective observational study on the policies and practices of early care and education (ECE) centers related to PA and screen-time.^{17,18} ECE centers were eligible to participate if they served children 3-5 years of age and were located in East Baton Rouge Parish, Louisiana, in the southeastern U.S. In total 10 randomly selected ECE centers chose to participate, stratified by Child and Adult Care Food Program funding status. Parents were recruited from the participating ECE centers through at least two of the following modes: informational handout/flyer, phone call, email, mail or in-person. Children were eligible if they were 3-4.9 years old, attended the ECE full time (at least 6 hours per day), and planned to attend the ECE center within the next year. Parents provided written consent. Baseline measurements were conducted between April 2016 and April 2017, and follow-up measurements were conducted approximately one year later between May 2017 and May 2018. Baseline data from the observational study were used for this analysis, along with children who newly enrolled in the follow-up year. Pennington Biomedical Research Center Institutional Review Board approved the study.

Sociodemographics

After consent, parents completed a demographic questionnaire. Parents reported their child's date of birth, sex, race, household size, and household income (<\$10,000, and then \$20,000

increments until \$140,000 and above). The time from the reported date of birth to visit date was used to calculate age. Poverty level was evaluated using reported household size and household income compared to national standards.¹⁹ Children were classified as at or below poverty level, or above poverty level. Trained researchers objectively measured height and weight twice to the nearest 0.1 cm and 0.1 kg, respectively, with shoes and jackets removed, and a third measure took place if the original two measurements were 0.5 units apart. Averaged measures were used to calculate age (in months) and sex adjusted body mass index (BMI) percentile and weight status classifications.²⁰

Movement Behaviors

Parents reported on average over the last 30 days how much time their child spent watching/using television, computer games, video games, smartphone, and tablet on a typical day using separate questions. These questions were based on the National Health and Nutrition Examination Survey (NHANES) 2009-2010 questionnaire and similar to previous screen-time reports.²¹ Responses included none, less than one hour, 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, or more than 5 hours with a fill in option. Responses of “less than one hour” responses were treated as a 0.5 hours, and the sum of screen-time from all devices was calculated.

Trained researchers placed an ActiGraph GT3X+ accelerometer on the hip of the child using an adjustable latex-free elastic waist/hip belt. Parents were asked that the accelerometer be worn continuously (24 hours) for seven days, with an additional day for familiarization (total eight days), and only removed for water-based activities. Non-wear-time was considered 30 minutes or greater periods of continuous zeroes similar to other studies,^{22,23} and these bouts were removed. The data were analyzed using age appropriate cut points for 15-second epochs including moderate-to-vigorous PA (MVPA) > 420 counts and 200 to 419 counts for light PA (LPA).^{24,25} Total PA was the sum of MVPA and LPA. Children with at least 4 days of 10 hours of wear were included for analysis to reflect in and out of school PA for preschoolers similar to other studies.^{26,27} Sleep time was determined through application of a previously published sleep algorithm developed from an international pediatric cohort, which differentiated non-wear from sleep time.²⁸ The algorithm utilized in this study has not been validated to detect nap time, thus sleep duration amounts included only night time sleep.

24-Hour Movement Guidelines

This study assessed all three components of the 24-Hour Movement Guidelines for Early Years, including sedentary screen-time, PA, and sleep.¹² The 24-Hour Movement Guidelines for children 2-5 years of age includes daily screen-time (1 hour), PA (3 hours total physical of which 1 hour is MVPA), and sleep (10-13 hours).¹² Children whose parents reported less than 60 minutes of total screen-time daily were classified as meeting the screen-time guideline. Children who engaged in at least three hours of total PA, including at least 60 minutes of MVPA daily, were classified as meeting the PA guideline. Children who slept between 10.0-13.0 hours daily were classified as meeting the sleep guideline. Number of guidelines was the sum of guidelines met.

Data Analysis

Exploratory and descriptive analyses were conducted for central tendencies and frequencies. Differences between categories of age, sex, race, poverty level, and weight status in relation to each specific guideline (i.e. PA, screen-time, and sleep) and number of guidelines met (1, 2 or 3) were assessed using chi-square analysis or Fisher exact tests. Independent t-tests and one-way ANOVA were conducted to assess difference in BMI percentile between those who met vs. did not meet specific guidelines and by number of guidelines met. To assess potential interactions, generalized linear regression models were used to examine main effects and the interaction term of sociodemographic characteristics on specific guidelines met and number of guidelines met. Significance was set at $p < 0.05$ for chi-square and main effects and $p < 0.10$ for interaction terms.²⁹ All analyses were conducted in SAS 9.4 (Cary, N.C.).

RESULTS

Seven hundred and four children (ages 3 to 4 years) attended the ECE centers that participated in this study, including both part-time and full-time enrolled children. One hundred and ninety of these children (26%) returned the consent form, though 15 children were ineligible either because they were not enrolled full-time ($n=1$) or were not returning to the ECE center the following year ($n=14$) via the initial survey with consent form. In total, 175 children from baseline assessments and 21 additional children from follow-up assessments were available for analysis ($n=196$). After removing those who refused the accelerometer ($n=1$), lost the accelerometer ($n=3$), were absent the day of assessment ($n=6$), had insufficient wear ($n=49$), were missing or refused to answer information on demographic survey ($n=24$), or were missing measured height and weight ($n=6$), 107 children had complete data. Those who did not provide complete data had a lower income and were predominantly African American compared to the included sample. As shown in Table 1, on average children were 3 years of age (57.9%), white (57.0%), and were above the poverty level (73.9%). Most children met the PA (91.5%) and sleep guideline (86.9%). Most children exceeded screen-time guidelines, with only 14.0% meeting the screen-time guideline. Parents reported that children averaged over 4 hours/day of screen-time with most of this time spent with TV and tablets.

Table 2 shows the sociodemographic differences in meeting specific movement guidelines. There was no difference between ages, sex, or weight status in meeting specific guidelines ($p > 0.05$) or differences in BMI percentile. However, African American children were less likely to meet the screen-time and sleep guideline compared to other races ($p=0.003$ and $p=0.001$, respectively). Further, no children at or below the poverty level met the screen-time guideline, and fewer children at or below the poverty level met the sleep guideline compared to children above the poverty level ($p=0.01$ and $p=0.008$, respectively).

Race and poverty level differences persisted when comparing the number of guidelines met (Table 3). No African American children met all three guidelines, and no children at or below the poverty level met all three guidelines ($p=0.0003$ vs. white children and $p=0.01$ vs. those above the poverty level, respectively). There were no differences for guidelines met by age, sex, BMI percentile or weight status ($p > 0.05$).

In further analysis evaluating race, poverty level, and their interaction (race $\times$ poverty level), the interaction term was related ($p=0.09$) to number of guidelines met. In those who were at or below the poverty level ($n=28$), there was no difference in race by number of guidelines met ($p=0.49$) and no children met all three guidelines. In children who were above the poverty level ($n=79$), there was a difference by race in number of guidelines met ($p=0.01$). No African American children who were above the poverty level ($n=11$) met all three guidelines, with most meeting two guidelines ($n=7$, 63.6%). Few white children met all three guidelines ($n=9$, 15%) though the majority met two guidelines ($n=46$, 76%). Most children of other races either met all three guidelines ($n=3$, 37.5%) or two guidelines ($n=3$, 37.5%). There were no other significant interactions ($p>0.10$).

DISCUSSION

In total, few preschoolers met the screen-time guideline, but most met the sleep and PA guidelines; therefore, most met at least two of the three guidelines. Parents reported their child averaged over 4 hours of daily screen-time, which is quadruple the screen-time guideline;¹² time spent with screens may prevent most children from achieving all three guidelines though further research is warranted. Fewer children who were African American and at or below the poverty level met the screen-time and sleep guidelines. These differences by race and poverty level provide evidence that there are important sociodemographic differences in attaining adequate screen-time, PA, and sleep among preschoolers.

In this sample, most children met the sleep and PA guideline, and few met the screen-time guideline or all three guidelines. Other reports in Canadian children in this age range also found that most children did meet the sleep guideline (83.9%) and few met all three guidelines (12.7%), similar to our results.¹³ The majority of children in our U.S. sample met the PA guideline (91.5%), higher than other reports of the 24-Hour Movement Guidelines in Canadian preschoolers (61.9%).¹³ Studies that have assessed PA using other guidelines, including only 1 hour MVPA daily³⁰ or 3 hours of total PA (or 15 minutes per hour^{9,10}) have observed lower rates meeting PA guidelines in the U.S. (35%³¹ and 50%,³² respectively) while using the same PA cut points. Portuguese preschoolers report similar guideline (1 hour MVPA daily and 3 hours of total PA) attainment to our sample (90%),³³ so our U.S. sample may be more active than other U.S. and Canadian reports. Despite sociodemographic differences in screen-time and sleep, these differences did not extend to the PA guidelines. ECEs can positively influence child PA,³⁴ and all children in this study were enrolled full-time, and thus they may be more active than other samples. This study had an even distribution of ECEs by poverty status from the study design, though there were no observed PA differences by poverty status unlike another study evaluating household income effects on young children's PA.³⁵

Children in this study acquired most of their screen-time from TV and tablet, similar to another study that estimated preschoolers spend over 2 hours a day engaged with screens.³⁶ However, a smaller amount of children in this study (14.0%) met the screen-time guidelines compared to a similar study (24.4%).¹³ This difference may be attributed to evaluation of only TV, video games, and computer for screen-time in the prior study,¹³ whereas this present study also queried parents about children's use of newer media devices of tablets and

smartphones, which may contribute additional screen-time.³⁷ Regardless, the screen-time guideline remained the least likely for preschoolers to attain in both samples.¹³ Unlike a recent evaluation in infants and toddlers (12-35 months of age),¹⁴ there was no difference in screen-time by age, though our comparisons were between 3 and 4 year olds, and differences may be seen across a larger age range such as from infancy (12 months) to preschool (5 years)¹⁶ or as children grow through adolescence.³⁸ A previous study observed more screen-time (including TV, video games, and computer usage) in African American children and children of lower income status compared to other race groups and higher income status, respectively,¹⁴ similar to the current study. Emerging evidence has suggested that household factors, including household disorganization or “chaos” and fewer screen-time limits by parents, are associated with increased screen-time.^{39,40} Children of lower income households experience a higher amount of household disorganization compared to their counter parts,³⁹ and African American adolescents who live in a more “chaotic” household utilize more screens as well.⁴¹ Thus, there may be a relationship between sociodemographic difference in screen-time and differences in household or parenting behaviors. In sum, there is evidence of differences in screen-time use when accounting for newer media devices, but new media use and related household practices in early childhood require additional investigation.

A previous study in this age range have found a difference by race and income on sleep duration.⁴² This other study found African American and Hispanic children have a lower sleep duration compared to white children, and those with lower income have lower sleep duration compared to higher income groups,⁴² similar to our findings. Sleep measurement involved self-report in that study, as opposed to objectively in the current study. Self-reported sleep may overestimate sleep time and be interpreted differently across cultures.⁴³ Therefore, this study contributes the objective assessment of sleep duration to detect sociodemographic differences between groups. The difference in sleep duration may be a result of poor bedtime routines and sleep schedule, as it has been reported that African American preschoolers have less consistent bedtime routines⁴⁴ and later sleep onset¹⁵ compared to white children, and these factors are associated with lower sleep duration.¹⁵ Lower sleep duration in low-income children and families may be a result of bed sharing, additional environmental noise, longer parent work hours, and bedroom TV access, which occur more frequently in these populations.^{43,45} Taken together, race and income status differences in meeting the sleep recommendations may be due to household and parental factors, similar to screen-time.

Studies have also found a relationship between screen-time and sleep duration, as these behaviors may be interrelated.^{6,42} Therefore, the similar findings of sociodemographic differences of race and poverty level between sleep and screen-time may be expected.⁴³ These findings suggest that targeting a reduction in screen-time, especially before bedtime,⁶ may have additional beneficial effects by increasing sleep duration and achieving the 24-Hour Movement Guidelines in these communities. Testing this hypothesis requires prospective and interventional research studies.

Data are mixed as to whether or not individual behaviors and guidelines are^{3,33,46,47} or are not^{13,46} associated with adiposity in this age range. In the present study, there were no

differences or associations with BMI percentile. Whether or not these associations emerge during early childhood, meeting guidelines has shown to be inversely associated with BMI and visceral fat in older children (5-18 years old),⁴⁸⁻⁵⁰ and individual and total guideline attainment is associated with child metabolic health.^{48,49} Longitudinal studies on the 24-Hour Movement Guidelines have been conducted in infancy to preschool,⁴⁶ though there are fewer data to indicate if meeting 24-Hour Movement Guidelines in early childhood impacts later child health outcomes.

There are several strengths to this investigation. This study is one of the few to objectively measure sleep and PA in context of the guidelines for young children, adding a less biased assessment than parent-report. Additionally, this study provides information on children's use of tablets and smartphones, which may contribute additional screen-time yet is currently understudied in studies of preschoolers. A strength of the study was diversity of the sample. The proportion of non-white participants (43%) is slightly higher compared to other studies evaluating race that included 23 to 31% non-white.^{15,42} However, the proportion of non-white children in this study was still slightly lower than East Baton Rouge Parish racial distribution (48.1% African American and 6% other race).⁵¹ The amount below the poverty level in this sample (26%) was higher than estimates in this county/parish (18.9%),⁵¹ which is likely due to including two ECEs that exclusively served children at or near the poverty level. The study was not designed to enroll a representative sample; as such these results may not be generalizable to other areas in the U.S. or elsewhere.

There were also several limitations to the study. Out-of-school screen-time was the focus of this study thus the screen-time observed at the ECE was not included, yet ECEs are an important part of a child's waking hours and may contribute to total screen-time. However, in previous reports using this same sample, most ECE centers had a zero screen-time (as in no screen-time at the center) or less than 30 minutes/day of screen-time policy.¹⁷ Therefore, the screen-time at the ECE centers in this sample may be very limited. The ECE center is also a place for sleep to occur (via naptime), though using the current algorithm²⁸ naptime sleep was not able to be identified. As naptime is included in the 24-Hour Movement Guidelines for Early Years, this investigation could not fully address the sleep guideline without naptime. As 87% of the sample met the sleep guideline, the missing naptime may have a negligible effect on the results of the current study. Previous reports have identified African American children may be more likely to nap at ECE centers, which may contribute to total sleep.⁴⁴ As screen-time and sleep may be related, the focus should remain on decreasing screen-time outside of the ECE center to increase nighttime sleep. The screen-time data were self-reported and subject to social desirability bias, which may have influenced parents to report less screen-time than their child actually obtained. Regardless, parents still reported much higher than the screen-time recommendation, suggesting that these parents may be reporting actual media usage.

The differences in these guidelines by other races and ethnicities requires further research, including children who are Hispanic and Asian. The size and racial/ethnic distribution of this sample limited the ability to evaluate these groups. As a part of this investigation, there was an assumption that screen-time viewing was independent from other activities like physical activity, and it was assumed that children were only viewing one screen at a time. Thus,

additional investigation into screen overlap and content may help to elucidate the influences of screen-time in this age range.⁵²

As the family plays a large role in each movement behavior, more research is needed on the influence of the household context and parenting behaviors on children attaining the 24-Hour Movement Guidelines. This research may help to identify targets for future interventions to reduce differences at this early age. The 24-Hour Movement Guidelines are relatively recent (published in 2016),⁵³ thus evaluation of these guidelines relative to other health indicators and understanding the long-term implications of meeting these guidelines on lifelong health is needed. The results of the current study do suggest to public health practitioners that it is important to assess multiple guidelines collectively to create a comprehensive picture of the child's movement patterns and identify areas for behavior change. On a larger scale, this study suggests that policies and programs should consider barriers faced by minority race groups and impoverished households when aiming to improve sleep and screen-time behaviors in young children.

Overall, most children in this sample met the sleep or PA guidelines but not the screen-time guideline. As screen-time, sleep, and PA can be interrelated, efforts to reduce screen-time and increase PA may help children attain the sleep guideline. Race and poverty level differences existed, with children who were African American and at or below the poverty level exhibiting more screen-time and less sleep relative to others. Future work should aim at decreasing the differences in movement behaviors between these groups to ensure that all children are attaining these 24-hour Movement Guidelines for their long-term health.

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Table 1.

Descriptive Characteristics of Participants (n=107)

<i>Demographics</i>	Mean	SD	%
Age			
3 years old			57.9
4 years old			42.1
Boy			50.4
Race			
White			57.0
African American			32.7
Other			10.3
Ethnicity			
Hispanic			5.6
Non-Hispanic			93.4
Household Size	3.87	1.08	
Household Income			
Less than \$29,999			25.3
\$30,000-\$69,999			6.5
\$70,000-\$109,999			18.7
Greater than \$120,000			49.5
Federal Poverty Status			
At or Below			26.1
Above			73.9
BMI Percentile	61.77	29.63	
Weight Status			
Underweight			5.6
Normal		64.5	
Overweight			20.5
Obese			9.4
<i>Movement Behaviors (hours/day)</i>			
Physical Activity	6.33	1.25	
Light Physical Activity	4.09	0.63	
MVPA	1.72	0.59	
Screen-Time	4.30	3.55	
TV	1.79	1.21	
Computer	0.59	0.87	
Video Games	0.35	0.70	
Smartphone	0.73	1.10	
Tablet	0.82	0.93	
Sleep	10.83	0.93	
<i>Guidelines Met</i>			
Physical Activity			91.5

<i>Demographics</i>	Mean	SD	%
Screen-Time			14.0
Sleep			86.9
Number of Guidelines Met			
1			18.6
2			70.1
3			11.3

Table 2.
Demographic Differences in Meeting Specific Movement Behavior Guidelines[^]

Demographic Variable	Physical Activity	Specific Guidelines Met			
		p value	Screen-time	p value	p value
Age		0.87		0.867	0.94
3 years old	91.9		14.5		87.1
4 years old	91.1		13.3		86.6
Sex		0.70		0.81	0.59
Boy	92.5		14.8		85.2
Girl	90.6		13.2		88.6
Race		0.19		0.003*	0.001*
White	90.2		19.8		96.7
African American	97.2		0.0		71.4
Other	81.8		27.2		81.8
Federal Poverty Level		0.10		0.01*	0.008*
At or Below	96.4		0		71.4
Above	89.8		18.9		92.4
BMI Status		0.82		0.37	0.74
Underweight	100.0		33.3		100.0
Normal	89.8		11.5		85.5
Overweight	90.9		18.2		90.9
Obese	100.0		10.0		80.0

[^] comparisons conducted using chi-square or fisher exact test with significant set at p<0.05.

* p<0.05

Table 3.Difference in Number of Guidelines met by Demographic Characteristic[^]

Demographic Variable	Number of Guidelines Met			p value
	1	2	3	
Age				0.95
3 years old	17.8	70.9	11.3	
4 years old	20.0	68.9	11.1	
Sex				0.72
Boy	20.4	66.7	12.9	
Girl	16.9	73.6	9.5	
Race				0.0003*
White	8.2	77.0	14.8	
African American	31.4	68.6	0	
Other	36.4	36.4	27.2	
Federal Poverty Level				0.01*
At or Below	32.1	67.8	0.0	
Above	13.9	70.9	15.2	
BMI Status				0.55
Underweight	0	66.6	33.3	
Normal	21.7	69.5	8.8	
Overweight	13.6	72.7	13.7	
Obese	20.0	70.0	10.0	

[^] comparisons conducted using chi-square or fisher exact test with significant set at p<0.05.

* p<0.05