

## U.S. Children Meeting Physical Activity, Screen Time, and Sleep Guidelines



Ciarán P. Friel, EdD,<sup>1,2</sup> Andrea T. Duran, PhD,<sup>1</sup> Ari Shechter, PhD,<sup>1</sup> Keith M. Diaz, PhD<sup>1</sup>

**Introduction:** Physical inactivity, high screen time, and short sleep are targets of public health initiatives for children. However, few data exist on how many U.S. children meet guidelines for these behaviors—data vital to inform which needs greater targeting. This study describes national prevalence estimates of U.S. children who meet physical activity, screen time, and sleep guidelines alone or in combination across each childhood year.

**Methods:** This analysis (completed in 2019) used cross-sectional data from the 2016–2017 National Survey of Children’s Health, a nationally representative sample of U.S. children. Child physical activity (days per week with  $\geq 60$  minutes), recreational screen time (hours per day of TV viewing and electronic device use), and sleep duration (hours per day) were assessed through parental report. Guidelines recommend  $\geq 60$  minutes per day of physical activity,  $\leq 2$  hours per day of screen time, and 9–12 hours per day of sleep for individuals aged 6–12 years (8–10 hours for those aged 13–17 years).

**Results:** Only 8.8% (95% CI=8.2%, 9.5%) of U.S. children meet all the 3 guidelines combined. Majority of children/adolescents attain the sleep guideline (86.0%, 95% CI=85.2%, 86.7%), but a lower proportion meet physical activity (23.0%, 95% CI=22.1%, 23.9%) or screen time (32.9%, 95% CI=31.9%, 33.8%) guidelines. A substantial age effect was identified, with prevalence of meeting each distinct guideline and all the 3 declining with age ( $p < 0.001$ ).

**Conclusions:** Few U.S. children meet all the 3 movement guidelines, with prevalence rates of children meeting guidelines declining with age. Although many meet sleep guidelines, few meet physical activity or screen time guidelines. Initiatives targeting physical activity and screen time, especially for adolescents, should be pursued.

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### INTRODUCTION

Health during childhood is a strong predictor of health in adulthood; evidence shows that healthy children are more likely to become healthy adults.<sup>1–3</sup> Disconcertingly, approximately 27% of U.S. children have a chronic health condition.<sup>4</sup> Notably, national rates of obesity, diabetes, and mental health impairment continue to increase among children and adolescents in the U.S.,<sup>4–7</sup> imposing significant personal and societal burdens.<sup>8,9</sup> In light of the immediate and long-term effects and accompanying comorbidities of these health conditions, there is a great need to optimize programs that address health behaviors in childhood. This is of particular importance because health behaviors in childhood track into adulthood and considering that

evidence suggests that the health benefits incurred from health behaviors carry forward into adulthood.<sup>10–12</sup>

Preventive public health initiatives for children and adolescents have focused primarily on lifestyle management, with a specific emphasis on time spent in moderate-to-vigorous physical activity (MVPA) each day. However, MVPA accounts for only a small proportion (~4%) of the

From the <sup>1</sup>Center for Behavioral Cardiovascular Health, Department of Medicine, Columbia University Medical Center, New York, New York; and <sup>2</sup>Center for Personalized Health, Feinstein Institutes of Medical Research, Northwell Health, Manhasset, New York

Address correspondence to: Ciarán P. Friel, EdD, Center for Personalized Health, Northwell Health, 130 East 59th Street, Suite 14C, New York, NY 10022. E-mail: [cfriel@northwell.edu](mailto:cfriel@northwell.edu).

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24-hour day. More recently, other behaviors along the movement continuum that comprise the 24-hour day, including time spent in sedentary behavior and time spent sleeping, have been acknowledged as additional modifiable considerations. Each of these 3 factors independently contributes to disease risk, including obesity, type 2 diabetes, and mental health disorders.<sup>13–18</sup> Thus, they have been targets of public health initiatives with parental/caregiver guidelines released on ideal levels of MVPA ( $\geq 60$  minutes per day),<sup>19</sup> sedentary time (in the form of recreational screen time;  $\leq 2$  hours per day),<sup>20</sup> and sleep (9–12 hours per day for individuals aged 6–12 years; 8–10 hours per day for those aged 13–17 years).<sup>16</sup>

Although benefits are accrued from meeting each individual movement guideline, preventive health initiatives that only focus efforts on a single factor (e.g., MVPA) limit the potential effect on health outcomes.<sup>21</sup> Emerging evidence suggests that appropriate levels of physical activity (PA), screen time, and sleep need to be achieved simultaneously (e.g., “a healthy 24 hours”) for optimal child health.<sup>22</sup> However, integrated 24-hour movement guidelines for children/adolescents do not yet exist in the U.S., and few data exist regarding the extent to which youth meet more than 1 of the individual recommendations (PA, screen time, or sleep). Failing to look at these factors in unison restricts the ability to understand how habitual movement behaviors interact to influence health outcomes. Such information is vital for informing public health programs and identifying which preventive measures are in most need of targeting. Initial evidence among a representative sample of U.S. high school-aged youth suggests that few (~5%) meet guidelines for PA, screen time, and sleep simultaneously.<sup>23</sup> However, it is unclear whether similar rates exist across all school-aged children in the U.S.

The purpose of this study is to calculate the national prevalence estimates of U.S. children and adolescents who meet PA, recreational screen time, and sleep guidelines alone or in combination. Furthermore, little evidence exists on the prevalence of meeting these guidelines as children age, thus limiting the possibility of designing age-tailored programs to promote adoption of these preventive health measures during childhood or discerning which health behaviors are in most need of targeting across age groups; therefore, comprehensive trend analyses across each year of childhood from ages 6 to 17 years are also conducted.

## METHODS

### Study Population

This analysis used data from the 2016 and 2017 National Survey of Children’s Health (NSCH), a nationally representative survey of

U.S. children aged 0–17 years since 2003.<sup>24</sup> Sample design and data collection procedures have been described previously<sup>25</sup> and are available online.<sup>24</sup> Households from all the 50 states were randomly selected and mailed a screener questionnaire querying information pertaining to children in the household. Those with children aged  $< 18$  years were then invited to complete a comprehensive topical questionnaire about the child online or through mail.

Across the 2016 and 2017 surveys, a total of 71,811 (36.1%) of 199,058 households completed the topical questionnaire. This analysis was restricted to children aged 6–17 years ( $n=51,156$ ) as data on PA were not collected on children aged  $< 6$  years. After excluding those who had missing data for PA, screen time, or sleep ( $n=1,550$ ), a total of 49,606 participants were included in the final analytic sample. The NSCH adhered to the U.S. Federal Policy for the protection of human subjects, and all participants provided informed consent.

### Measures

Children’s PA was assessed by parental response to the question: *During the past week, on how many days did this child exercise, play a sport, or participate in physical activity for at least 60 minutes?* Response options were: *0 days, 1–3 days, 4–6 days, or every day.* Children were classified as meeting PA guidelines if their parent chose the response option of *every day*.<sup>19</sup>

Recreational screen time was calculated from 2 questions that queried TV viewing and electronic device use. Time spent in these screen-based activities was assessed by the questions: *On an average weekday, about how much time does this child usually spend in front of a TV watching TV programs, videos, or playing video games?* and *On an average weekday, about how much time does this child usually spend with computers, cell phones, handheld video games, and other electronic devices doing things other than schoolwork?* Response options were: *none, <1 hour, 1 hour, 2 hours, 3 hours, or 4 or more hours.* TV viewing and electronic device use responses were summed to derive hours per day of screen time (with the *less than 1-hour* response option set to the midpoint of 0.5 hours). Children with a total of  $\leq 2$  hours per day of recreational screen time were classified as meeting screen time guidelines.<sup>15,20</sup>

Sleep was assessed by parental response to the question: *During the past week, how many hours of sleep did this child get on most weeknights?* Response options were: *<6 hours, 7 hours, 8 hours, 9 hours, 10 hours, and 11 or more hours.* Children were classified as meeting sleep guidelines if their parents chose a response option that agreed with the recommended 9–11 hours for children aged 6–13 years or 8–10 hours for those aged 14–17 years.<sup>16</sup>

Sociodemographic and lifestyle characteristics derived from the NSCH topical questionnaire included age, sex, race, Hispanic ethnicity, household poverty level, and BMI. A detailed summary of sociodemographic/lifestyle measures is provided in the [Appendix](#) (available online).

### Statistical Analysis

To produce nationally representative estimates, survey analysis procedures were used to account for sample weights, stratification, and clustering of the complex survey design. The prevalences and 95% CIs of meeting 0, 1, 2, or all the 3 of the movement guidelines were estimated overall among all U.S. children/adolescents and

stratified by sociodemographic characteristics including age group (children aged 6–11 years and adolescents aged 12–17 years), sex, race, Hispanic ethnicity, household poverty level, and BMI category. The prevalence of meeting each guideline individually and in different combinations (e.g., meeting PA and screen time but not sleep guidelines) were also estimated.

Logistic regression modeling was used to assess the association of sociodemographic and lifestyle characteristics with meeting each movement guideline and all the 3 simultaneously. Models were adjusted for age, sex, race, Hispanic ethnicity, and household poverty level. The authors did not adjust for BMI in the primary models because BMI classification in the NSCH was limited to children aged 10–17 years. As a secondary analysis, the association of BMI category with meeting each movement guidelines and all the 3 simultaneously was also examined with adjustment for the above-listed covariates. To examine the degree to which each characteristic was predictive of meeting movement guidelines, the difference in variance ( $\Delta R^2$ ) between the full model and the model when omitting each specific characteristic (i.e., each variable uniquely accounts for a proportion of the variance accounted for by all the variables combined) was calculated and expressed as the percentage of a model's  $R^2$  value.

To evaluate trends in meeting movement guidelines with increasing age, the prevalence and 95% CI of meeting guidelines in each year of childhood from ages 6 to 17 years were estimated. Linear trends (i.e.,  $p$ -trend) in prevalence estimates across age groups were evaluated using generalized additive models with adjustments for sex, race, Hispanic ethnicity, and household poverty level. To inform which specific screen time habits differ by age, a secondary analysis was conducted examining age trends for prevalence of TV viewing  $\leq 2$  hours per day and electronic device use  $\leq 2$  hours per day separately. Analyses were conducted in 2019 using SAS, version 9.4.

## RESULTS

Table 1 shows the estimated prevalence of those meeting each specific guideline and meeting all the 3, stratified by demographic characteristics. Overall, only 8.8% (95% CI=8.2%, 9.5%) of children/adolescents met all the 3 guidelines; however, a majority (91.2%) met at least 1 of the guidelines with 49.4% (95% CI=48.4%, 50.5%) and 33.0% (95% CI=32.0%, 34.0%) meeting 1 and 2 guidelines, respectively (Figure 1 and Appendix Table 1, available online). Most children/adolescents (86.0%, 95% CI=85.2%, 86.7%) met sleep guidelines, but only 32.9% (95% CI=31.9%, 33.8%) met screen time and 23.0% (95% CI=22.1%, 23.9%) met PA guidelines. Across age groups, children had the highest estimated prevalence of achieving all the 3 guidelines (12.9%, 95% CI=11.8%, 14.0% vs 4.7%, 95% CI=4.1%, 5.4% for adolescents). A higher estimated percentage of children than adolescents also met each of the discrete guidelines for PA (27.8%, 95% CI=26.4, 29.3% vs 18.2%, 95% CI=17.0%, 19.4%), screen time (44.8%, 95% CI=43.2%, 46.3% vs 20.9%, 95% CI=19.8%, 22.1%), and sleep (88.7%, 95% CI=87.8%, 89.7% vs 83.2%, 95% CI=82.1%, 84.3%).

Appendix Table 2 (available online) shows the estimated prevalence of children/adolescents meeting the various combinations of guidelines (e.g., screen time + sleep).

Being female (versus male); an adolescent (versus child); black, Asian, or other race (versus white race); and underweight, overweight, or obese (versus normal weight) were all significantly associated with a lower likelihood of meeting all the 3 guidelines (Table 2). When examining each specific guideline, adolescents and those who had BMI classifications of overweight and obese were notably less likely to meet PA, screen time, and sleep guidelines. No consistent pattern of differences emerged for all other demographic subgroups. Appendix Table 3 (available online) shows the ORs for meeting each of the possible combinations of guidelines.

The estimated prevalence of meeting 2 or 3 guidelines significantly decreased with increasing age, whereas the estimated prevalence of meeting 0 or only 1 guideline significantly increased with increasing age ( $p < 0.001$ ) (Figure 2 and Appendix Table 4, available online). From ages 6 to 17 years, the estimated prevalence of meeting all the 3 guidelines decreased from 15.9% (95% CI=12.5%, 19.2%) to 2.8% (95% CI=2.1%, 3.7%).

The estimated prevalence of meeting each of the PA, screen time, and sleep guidelines separately significantly decreased with increasing age ( $p < 0.001$ ) (Appendix Figure 1, available online, and Appendix Table 5, available online). From age 6 to 17 years, the estimated prevalence of meeting PA, screen time, and sleep guidelines declined by 15.5%, 33.8%, and 8.8%, respectively. The largest year-to-year declines occurred from ages 10 to 11 years for PA (decline of 5.4%) and screen time (decline of 11.0%) guidelines. For sleep, the largest year-to-year decline occurred from age 15 to 16 years (decline of 8.0%). When TV viewing and electronic device use were evaluated separately, the prevalence of children/adolescents watching TV for  $\leq 2$  hours per day declined by 10.2% from age 6 to 17 years, whereas the prevalence of electronic device use for  $\leq 2$  hours per day declined by 50.5% ( $p$ -trend  $< 0.001$ ) (Appendix Table 6, available online).

## DISCUSSION

In this nationally representative survey, it was estimated that fewer than 1 in 10 ( $\sim 9\%$ ) U.S. children/adolescents would meet all the 3 movement guidelines (PA, screen time, and sleep), although most would meet at least 1 ( $\sim 91\%$ ). A large proportion of children/adolescents achieve the recommended amount of sleep (86%), but a much lower percentage meet guidelines for PA (23%) and screen time (33%). A substantial age effect was also identified as the estimated prevalence of meeting each and all the 3 movement guidelines decreased with age.

**Table 1.** Estimated Prevalence of U.S. Children/Adolescents Meeting Movement Guidelines (PA/Screen Time/Sleep)

Characteristics	Unweighted sample size, <i>n</i>	Guidelines met				
		None, weighted % (95% CI)	PA, <sup>a</sup> weighted % (95% CI)	Screen time, <sup>b</sup> weighted % (95% CI)	Sleep, <sup>c</sup> weighted % (95% CI)	PA + screen time + sleep, weighted % (95% CI)
Overall	49,606	8.8 (8.2, 9.4)	23.0 (22.1, 23.9)	32.9 (31.9, 33.8)	86.0 (85.2, 86.7)	8.8 (8.2, 9.5)
Sex						
Female	24,242	9.7 (8.8, 10.6)	19.4 (18.1, 20.6)	33.6 (32.1, 35.0)	85.4 (84.3, 86.5)	7.8 (6.9, 8.9)
Male	25,364	7.9 (7.2, 8.7)	26.5 (25.2, 27.8)	32.2 (30.9, 33.5)	86.6 (85.6, 87.6)	9.7 (9.0, 10.6)
Age groups						
Children (aged 6–11 years)	20,919	5.3 (4.6, 6.2)	27.8 (26.4, 29.3)	44.8 (43.2, 46.3)	88.7 (87.8, 89.7)	12.9 (11.8, 14.0)
Adolescents (aged 12–17 years)	28,687	12.2 (11.3, 13.1)	18.2 (17.0, 19.4)	20.9 (19.8, 22.1)	83.2 (82.1, 84.3)	4.7 (4.1, 5.4)
Race/ethnicity						
White	38,444	7.2 (6.6, 7.8)	23.2 (22.2, 24.3)	36.0 (34.8, 37.2)	88.1 (87.4, 88.9)	10.1 (9.3, 10.9)
Black	3,219	16.5 (14.1, 19.0)	24.8 (22.1, 27.4)	20.6 (18.3, 23.0)	75.9 (73.1, 78.7)	4.8 (3.7, 6.2)
Asian	2,699	6.2 (4.8, 8.0)	16.4 (13.0, 19.7)	38.1 (34.2, 42.0)	88.0 (85.3, 90.1)	6.1 (4.5, 8.1)
Other <sup>d</sup>	5,244	9.1 (7.6, 10.8)	22.3 (19.4, 25.3)	28.7 (25.8, 31.5)	85.4 (83.4, 90.8)	7.5 (6.0, 9.4)
Ethnicity						
Non-Hispanic	44,115	8.5 (8.0, 9.2)	23.7 (22.8, 24.5)	34.5 (33.6, 35.5)	86.0 (85.3, 86.8)	9.2 (8.7, 9.8)
Hispanic	5,491	9.4 (7.9, 11.0)	21.1 (18.5, 23.7)	27.9 (25.1, 30.7)	85.8 (83.8, 87.7)	7.6 (6.0, 9.7)
Family poverty-to-income ratio level, %						
<200	12,669	11.0 (9.8, 12.2)	26.3 (24.6, 28.1)	27.7 (25.9, 29.5)	82.9 (81.5, 84.3)	8.7 (7.5, 10.0)
200–299	8,131	7.4 (6.4, 8.5)	22.7 (20.6, 24.8)	32.4 (30.1, 34.6)	88.0 (86.7, 89.4)	8.7 (7.4, 10.1)
300–399	7,675	7.7 (6.6, 9.0)	19.0 (16.9, 21.0)	34.8 (32.3, 37.2)	87.4 (85.5, 89.3)	7.4 (6.4, 8.6)
≥400	21,131	6.6 (6.0, 7.3)	20.1 (19.0, 21.2)	39.9 (38.5, 41.2)	88.7 (87.8, 89.6)	9.7 (8.8, 10.6)
<i>p</i> -trend		<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	0.476
BMI <sup>e</sup>						
Underweight (BMI <5th percentile)	2,124	9.0 (6.5, 12.3)	17.5 (14.3, 20.8)	30.3 (26.1, 34.5)	86.2 (82.6, 89.8)	4.0 (3.0, 5.4)
Normal weight (5th–85th percentile)	22,903	8.8 (8.1, 9.6)	21.4 (20.0, 22.7)	27.4 (26.0, 28.7)	86.6 (85.6, 87.6)	6.7 (6.0, 7.6)
Overweight (BMI 85th–94th percentile)	4,888	12.6 (10.5, 14.7)	16.5 (13.8, 19.2)	21.0 (18.4, 23.6)	82.8 (80.1, 85.6)	4.6 (3.2, 6.5)
Obese (BMI ≥95th percentile)	4,386	16.1 (13.3, 19.0)	14.5 (11.7, 17.2)	17.7 (14.9, 20.5)	79.1 (76.0, 82.2)	4.3 (3.0, 6.2)

Note: Boldface indicates statistical significance ( $p < 0.001$ ). All estimates were weighted to be nationally representative.

<sup>a</sup>Defined as PA ≥60 minutes every day.

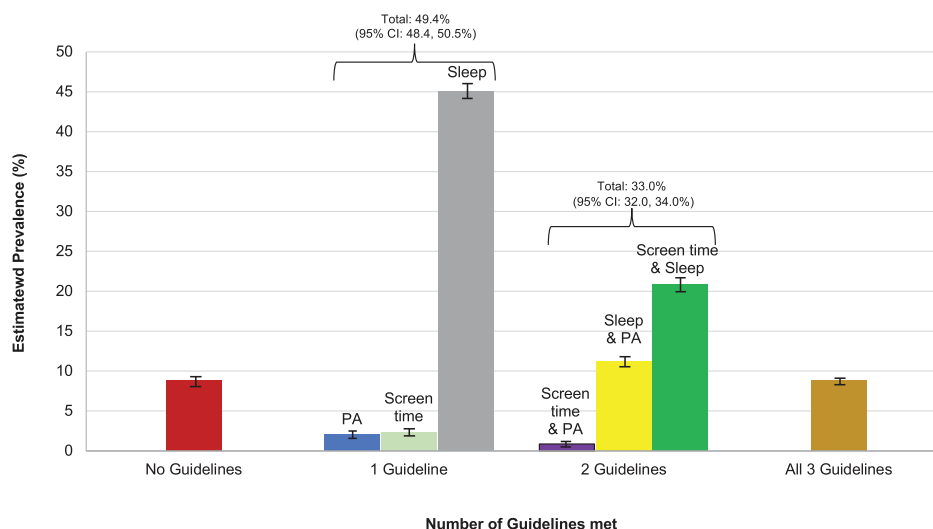
<sup>b</sup>Defined as screen time ≤2 hours each day.

<sup>c</sup>Defined as sleep duration per night between 9 and 11 hours (ages 6–13 years) or between 8 and 10 hours (ages 14–17 years).

<sup>d</sup>Other race category includes American Indian or Alaska Native (unweighted  $n = 369$ ), Native Hawaiian and other Pacific Islander (unweighted  $n = 162$ ), some other race (unweighted  $n = 1,261$ ), and 2 or more races (unweighted  $n = 3,452$ ).

<sup>e</sup>BMI data only available for those aged 10–17 years.

PA, physical activity.



**Figure 1.** Estimated prevalence of meeting 0, 1, 2, or 3 of the movement guidelines (PA, screen time, or sleep) in the 2016–2017 NSCH. Data are weighted to be nationally representative. Error bars indicate 95% CI. NSCH, National Survey of Children’s Health; PA, physical activity.

Notably, from ages 6 to 17 years, the estimated prevalence of children meeting all the 3 guidelines decreased approximately by 13%, with almost none (~2%) meeting all the 3 by age 17 years.

Historically, preventive health interventions targeting movement behaviors in children have focused on each aspect of the movement continuum in isolation.<sup>26–29</sup> However, emerging evidence shows these movement behaviors interact such that their combined effects (i.e., meeting all 3 guidelines) on health indicators are greater than their individual effects. For example, in a sample of >6,000 children from 12 countries, meeting all the 3 movement behavior recommendations was associated with a 72% lower likelihood of obesity versus a 55%, 14%, and 33% lower likelihood of obesity when individually meeting PA, sedentary time, and sleep time guidelines, respectively.<sup>30</sup> Similar findings have been reported for other health indicators of cardiometabolic risk and cognition.<sup>30–32</sup> This growing body of research has informed a paradigm shift toward an integrated model that incorporates all 24-hour movement behaviors to optimize health benefits rather than focusing on a single specific behavior.<sup>32</sup> Notably, 24-hour movement guidelines for children/adolescents have been released in Canada and Australia that recommend optimization of PA, sedentary behavior, and sleep simultaneously.<sup>33,34</sup> As such guidelines continue to develop, there is a need to identify how specific countries meet such recommendations and identify where deficits lie with respect to meeting each of the movement guidelines. This study reports that only around 9% of U.S. children/adolescents meet all the 3 movement guidelines. Similar findings

(~2%–5% meeting all the 3 guidelines) have been reported in nonrepresentative U.S. samples.<sup>30,32</sup> This is lower than the 17.5% of Canadian and 14.9% of Australian youth meeting all the 3 guidelines in previous studies.<sup>22,30</sup> With rising rates of chronic diseases in children and young adults in the U.S., these findings highlight a sizable public health problem that if targeted may help to mitigate rising chronic disease rates. Notably, these findings suggest that efforts targeting reductions in recreational screen time and increases in PA are most needed to optimize movement behaviors among U.S. youth.

A key finding of this study is the observed decreases from childhood to adolescence in those achieving each movement guideline and all the 3 in combination. Previous results from the Youth Risk Behavior Surveillance Survey showed that only 5% of U.S. adolescents met all movement recommendations.<sup>23</sup> This study extends upon this work by reporting prevalence estimates among children (13% meeting all the 3 guidelines) versus adolescents (5% meeting all the 3) and evaluating age trends across childhood. From ages 6 to 17 years, the prevalence of meeting all the 3 and each specific guideline declined, with <3% of 17-year-olds meeting all the 3 and <20% meeting PA and screen time guidelines, respectively. Such findings are alarming given the substantive literature showing that movement behaviors in adolescence are predictive of movement behaviors in adulthood.<sup>35–37</sup> Notably, the largest decline among movements behaviors was observed for screen time, with more than half (52%) of 6-year-olds meeting recommendations versus 18% of 17-year-olds. When

**Table 2.** Adjusted Relative Odds of U.S. Children/Adolescents Meeting Movement Guidelines (PA/Screen Time/Sleep)

Characteristics	Guidelines met			
	PA, <sup>a</sup> OR (95% CI)	Screen time, <sup>b</sup> OR (95% CI)	Sleep, <sup>c</sup> OR (95% CI)	PA + screen time + sleep, OR (95% CI)
<b>Sex</b>				
Female	<b>0.66 (0.59, 0.74)</b>	1.01 (0.98, 1.18)	0.90 (0.80, 1.02)	0.63 (0.50, 0.80)
Male	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
$\Delta R,^d$ %	25.2	0.3	1.3	3.8
<b>Age groups</b>				
Children (aged 6–11 years)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Adolescents (aged 12–17 years)	<b>0.58 (0.52, 0.64)</b>	<b>0.31 (0.29, 0.35)</b>	<b>0.63 (0.56, 0.71)</b>	<b>0.44 (0.35, 0.56)</b>
$\Delta R,^d$ %	44.1	71.9	26.9	71.0
<b>Race</b>				
White	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Black	0.95 (0.82, 1.11)	<b>0.49 (0.42, 0.57)</b>	<b>0.46 (0.39, 0.55)</b>	<b>0.47 (0.30, 0.71)</b>
Asian	<b>0.62 (0.48, 0.80)</b>	1.06 (0.90, 1.26)	1.00 (0.76, 1.32)	<b>0.59 (0.35, 0.99)</b>
Other <sup>e</sup>	0.97 (0.80, 1.17)	<b>0.80 (0.68, 0.95)</b>	0.84 (0.69, 1.02)	<b>0.61 (0.38, 0.98)</b>
$\Delta R,^d$ %	4.9	11.2	42.7	18.8
<b>Ethnicity</b>				
Non-Hispanic	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Hispanic	<b>0.75 (0.63, 0.88)</b>	<b>0.73 (0.63, 0.86)</b>	0.95 (0.79, 1.14)	0.88 (0.61, 1.29)
$\Delta R,^d$ %	7.7	3.0	0.0	4.1
<b>Family poverty-to-income ratio level, %</b>				
<200	<b>1.50 (1.34, 1.69)</b>	<b>0.64 (0.57, 0.71)</b>	<b>0.70 (0.61, 0.80)</b>	1.24 (0.94, 1.64)
200–299	<b>1.19 (1.03, 1.37)</b>	<b>0.75 (0.66, 0.84)</b>	0.99 (0.85, 1.16)	0.88 (0.65, 1.19)
300–399	0.93 (0.79, 1.08)	<b>0.82 (0.73, 0.92)</b>	0.90 (0.74, 1.16)	<b>0.70 (0.54, 0.92)</b>
≥400	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
<i>p</i> -trend	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>0.107</b>
$\Delta R,^d$ %	21.0	6.9	13.2	2.4
<b>BMI<sup>f</sup></b>				
Underweight (BMI <5th percentile)	<b>0.69 (0.54, 0.88)</b>	<b>1.00 (0.81, 1.25)</b>	0.89 (0.65, 1.21)	<b>0.49 (0.35, 0.68)</b>
Normal weight (5th–85th percentile)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Overweight (BMI 85th–94th percentile)	<b>0.69 (0.55, 0.85)</b>	<b>0.71 (0.60, 0.85)</b>	<b>0.79 (0.63, 0.98)</b>	<b>0.65 (0.44, 0.94)</b>
Obese (BMI ≥95th percentile)	0.52 (0.41, 0.66)	<b>0.60 (0.48, 0.73)</b>	<b>0.64 (0.52, 0.78)</b>	<b>0.57 (0.38, 0.86)</b>
$\Delta R,^d$ %	25.8	16.5	12.5	19.4

Note: Boldface indicates statistical significance ( $p < 0.001$ ).

All estimates were weighted to be nationally representative. All models adjusted for sex, age, race, ethnicity, and family poverty-to-income ratio.  $\Delta R$  reflects the percentage of variance explained (e.g., percentage of a model's  $R^2$ ) by each variable.

<sup>a</sup>Defined as PA ≥60 minutes every day.

<sup>b</sup>Defined as screen time ≤2 hours each day.

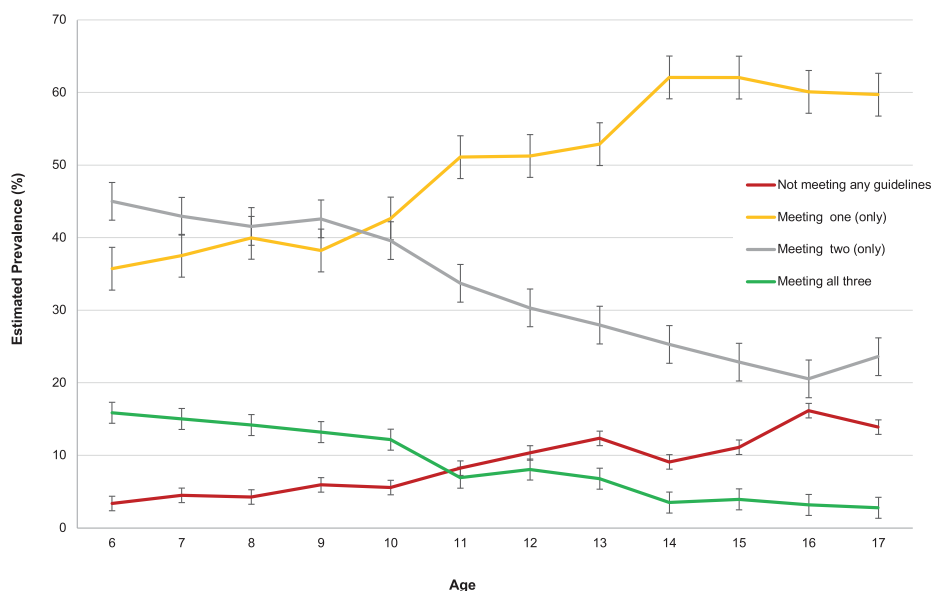
<sup>c</sup>Defined as sleep duration per night between 9 and 11 hours (for individuals aged 6–13 years) or between 8 and 10 hours (for those aged 14–17 years).

<sup>d</sup>Denotes the unique variance accounted for by each variable (i.e., the difference in variance between the full model and the model when omitting each specific characteristic).

<sup>e</sup>Other race category includes American Indian or Alaska Native (unweighted  $n=369$ ), Native Hawaiian and other Pacific Islander (unweighted  $n=162$ ), some other race (unweighted  $n=1,261$ ), and 2 or more races (unweighted  $n=3,452$ ).

<sup>f</sup>BMI data were only available for those aged 10–17 years.

PA, physical activity.



**Figure 2.** Estimated prevalence of children and adolescents meeting 0, 1, 2, or 3 of the movement guidelines by age in the 2016–2017 NSCH. Data are weighted to be nationally representative. Error bars indicate 95% CI. NSCH, National Survey of Children’s Health.

assessing screen time by its parts (TV viewing and electronic device use), the proportion of children who used electronic devices for  $\leq 2$  hours per day declined by 50% from ages 6 to 17 years, whereas TV viewing for  $\leq 2$  hours per day declined by only approximately 10%. Thus, the decline in children meeting screen time guidelines was largely driven by increased electronic device use. Although the contributing factors to the decline in the number of children/adolescents who used electronic devices for  $\leq 2$  hours per day are unclear, market research shows that the average age for getting a first phone is 10.3 years, with 95% of U.S. teens reporting phone access in 2018.<sup>38</sup> Thus, increased access to smartphones and other electronic devices, which are typically restricted in younger children, may be a contributing factor. Consistent with market research, the authors observed the largest declines in meeting PA and screen time guidelines from ages 10 to 11 years, suggesting that efforts targeting increases in PA/reductions in sedentary behavior may be warranted during early adolescence when electronic device access may be increasing.

### Limitations

This study has several limitations. First, the NSCH comprises a survey sample and is therefore subject to nonresponse bias. Response rates in the NSCH tend to be lower in urban areas and among low-income and ethnic minority populations.<sup>39</sup> However, nonresponse adjustment to the survey weights in the NSCH reduces the potential magnitude of these biases. Second, the NSCH

is cross-sectional in nature. Third, all NSCH data, including movement behaviors, were parent-reported and may be subject to recall and response bias as well as measurement error.<sup>40</sup> For example, parents may misjudge PA intensity and be unable to accurately quantify PA during the times away from home (e.g., school), thus leading to a possible under- or over-estimation of the true prevalence of meeting MVPA guidelines.<sup>41</sup> Fourth, relative to PA, which was assessed over a typical week (including weekends), screen time and sleep were assessed only on weekdays. Thus, the difference in measurement precision for assessing PA and sleep/screen time may have affected the findings. For example, it is unclear whether average daily sleep is represented accurately considering weekday versus weekend sleep variability and the possibility of sleep compensation on weekends. Finally, the NSCH survey questions assessing screen time did not ascertain active video gaming or device use while moving (e.g., texting while walking). Thus, some PA may be misclassified as screen time.<sup>42</sup> Future studies should include objective measures of movement across the 24-hour period, including weekend days, to present a more accurate reflection of children’s behaviors.

### CONCLUSIONS

In a large national survey of children in the U.S., prevalence estimates suggest that fewer than 1 in 10 children meet all the 3 movement guidelines. Low compliance

with PA and screen time guidelines were the primary contributing factors because most U.S. children met sleep guidelines. Thus, public health initiatives targeting replacing screen time with PA during leisure time may be warranted. Importantly, it was observed that the proportion of U.S. children meeting all the 3 guidelines substantially decreased with age, with <3% of 17-year-olds meeting all the 3. As such, these data indicate that most U.S. adolescents are transitioning into adulthood with poor movement behaviors across the 24-hour period that will likely predispose them to heightened cardiometabolic risk at an early age. These findings highlight a pressing need to develop health promotion programs for children and adolescents that address a healthy 24 hours, targeting PA, recreational screen time, and sleep concurrently, to curtail the rising chronic disease burden in the U.S.

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## SUPPLEMENTAL MATERIAL

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