

Physical Activity and Screen-Time Viewing Among Elementary School-Aged Children in the United States From 2009 to 2010

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Objectives: To describe the percentage of children who met physical activity and screen-time recommendations and to examine demographic differences. Recommendations for school-aged children include 60 minutes of daily moderate-to-vigorous physical activity and no more than 2 hours per day of screen-time viewing.

Design: Cross-sectional study.

Setting: Data from the 2009-2010 National Health and Nutrition Examination Survey, a representative sample of the US population.

Participants: Analysis included 1218 children 6 to 11 years of age.

Main Exposures: Age, race/ethnicity, sex, income, family structure, and obesity status.

Main Outcome Measures: Proxy-reported adherence to physical activity and screen-time recommendations, separately and concurrently.

Results: Based on proxy reports, overall, 70% of children met physical activity recommendations, and 54% met screen-time viewing recommendations. Although Hispanics were less likely to meet physical activity recommendations (adjusted odds ratio [aOR], 0.60 [95% CI, 0.38-0.95]), they were more likely to meet screen-time recommendations compared with non-Hispanic whites (aOR, 1.69 [95% CI, 1.18-2.43]). Only 38% met both recommendations concurrently. Age (9-11 years vs 6-8 years: aOR, 0.57 [95% CI, 0.38-0.85]) and obesity (aOR, 0.53 [95% CI, 0.38-0.73]) were inversely associated with concurrent adherence to both recommendations.

Conclusions: Fewer than 4 in 10 children met both physical activity and screen-time recommendations concurrently. The prevalence of sedentary behavior was higher in older children. Low levels of screen-time viewing may not necessarily predict higher levels of physical activity.

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PHYSICAL ACTIVITY AND SEDENTARY behaviors in children are associated with overall physical, psychological, and psychosocial well-being.¹⁻¹² Children who are physically active have a lower adiposity, more favorable lipid profiles, and increased cognitive function compared with their inactive counterparts.^{2,3} Independent of moderate-to-vigorous physical activity (MVPA), sedentary behaviors, such as watching television (TV), playing video games, and using a computer, have been associated with being overweight and obese and having higher serum cholesterol levels, blood pressure, and glycohemoglobin levels.⁴ Importantly, physical activity and sedentary behaviors track from childhood to adulthood.¹³⁻¹⁶

The 2008 Physical Activity Guidelines for Americans,¹ a National Heart,

Lung, and Blood Institute–supported Expert Panel, and the American Academy of Pediatrics^{2,17,18} recommend that children participate in daily MVPA for at least 60 minutes. The National Heart, Lung, and Blood Institute–supported Expert Panel and the American Academy of Pediatrics also recommend that children limit leisure screen-time viewing to 2 hours per day or less.^{2,17-19} However, little is known about adherence to physical activity and screen-time recommendations among US children.²⁰⁻²⁴ We used nationally representative data from the 2009-2010 National Health and Nutrition Examination Survey (NHANES) to provide the most recent prevalence estimates of elementary school-aged children who meet recommendations for physical activity and screen-time viewing. We also examined associations between adherence to recommendations and previously described cor-

relates of physical activity and screen-time viewing, including age, sex, race/ethnicity, family income to poverty level ratio, family structure, and obesity.

METHODS

STUDY DESIGN AND POPULATION

Data from the 2009-2010 NHANES were used in this analysis.²⁵ The NHANES is a continuous survey conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention to assess the health and nutritional status of the US noninstitutionalized population. The survey combines both an in-home interview and a physical examination in specially designed and equipped mobile trailers, which travel to locations throughout the country. The NHANES uses a complex, multistage, probability sampling design to select participants. The survey is designed to sample larger numbers of certain subgroups. In 2009-2010, non-Hispanic blacks, Hispanics, and low-income persons were oversampled among other groups. The oversampling of these specific subgroups increases the reliability and precision of estimates. Our analysis was restricted to elementary school-aged children (6-11 years of age) for 3 reasons. First, physical activity guidelines for preschool-aged children (2-5 years of age) are not well defined.²⁶ Second, physical activity was assessed differently for adolescents 12 to 19 years of age in 2009-2010. Lastly, screen-time viewing was not assessed for those 12 to 19 years of age in 2009-2010. Of the school-aged children selected to participate in the 2009-2010 NHANES, 88% were interviewed, and 84% were interviewed and examined.²⁷ The NHANES protocol was approved by the National Center for Health Statistics ethics review board. Informed parental consent was obtained for children 6 years of age, and both parental consent and child assent were obtained for children 7 to 11 years of age. A proxy respondent, most often a parent, answered interview questions.

PHYSICAL ACTIVITY AND SCREEN-TIME VARIABLES

In the 2009-2010 NHANES, physical activity and screen-time viewing by children 6 to 11 years of age were assessed using proxy reports only; accelerometer data were not included in the 2009-2010 survey. Proxy respondents were asked several questions using the Computer-Assisted Personal Interviewing system during the household interview. The proxy respondent answered the following question: "During the past 7 days, on how many days was [child's name] physically active for a total of at least 60 minutes per day? Add up all the time [child's name] spent in any kind of physical activity that increased [his/her] heart rate and made [him/her] breathe hard some of the time." Responses ranged from 0 to 7 days. Children were categorized as meeting recommendations if the response to the physical activity question was 7 days per week.

Screen time was defined as time spent watching TV or videos, playing computer games, or using a computer outside of school. Screen time was estimated from responses to 2 separate questions: (1) "Over the past 30 days, on average how many hours per day did [child's name] sit and watch TV or videos?" (2) "Over the past 30 days, on average about how many hours per day did [child's name] use a computer or play computer games outside of school?" For both questions, response options were as follows: none, less than 1 hour, 1 hour, 2 hours, 3 hours, 4 hours, and 5 or more hours. The options "none" and "less than 1 hour" were combined for this analysis and treated as less than 1 hour. Screen time was calculated by adding the

time contributed from both questions. Children were categorized as meeting screen-time recommendations if the combined screen time was 2 hours or less per day.

DEMOGRAPHIC VARIABLES, FAMILY INCOME TO POVERTY LEVEL RATIO, FAMILY STRUCTURE, AND OBESITY STATUS

Demographic and socioeconomic questions were also asked in the household interview. The proxy respondent reported race/ethnicity for the child. For our analysis, racial/ethnic groups were categorized as non-Hispanic white, non-Hispanic black, Hispanic, and other (primarily individuals of Asian descent, American Indians, Alaska Natives, and multiracial participants). Analyses of the total analytic sample included the "other" group; however, this group did not have a sufficient sample size to be analyzed separately. Age was categorized as 6 to 8 years of age and 9 to 11 years of age. Finer 1-year stratifications of age were not possible owing to the small sample size.

Three measures of socioeconomic status and family structure were included in the analysis: family income to poverty level ratio (FIPR), the highest level of education attained by the head of household, and the marital status of the head of household. The head of household was defined as the person who rents or owns the residence where members of the household live. The FIPR was calculated by dividing family income by a poverty threshold specific for family size. The US Department of Health and Human Services' poverty guidelines were used as the poverty measure to calculate the FIPR.²⁸ Income eligibility for participation in the Supplemental Nutrition Assistance Program (formerly known as the Food Stamp Program) is 130% of the FIPR (<130% FIPR).²⁹ We used this cut point in our analyses: larger FIPRs indicate greater income. The level of education attained by the head of household was classified as less than high school, completed high school or general equivalency diploma, and more than high school. The marital status of the head of household was dichotomized into married or living with a partner and single. The "single" category includes those heads of households who were never married, those separated, those divorced, and those widowed. The dichotomization of marital status was performed to investigate whether meeting recommendations was associated with living in a single- vs dual-parent household.

Obesity status was defined based on body mass index (calculated as weight in kilograms divided by height in meters squared). Body mass index was calculated using measured height and weight obtained during the standardized physical examination in the mobile examination center. Children at or above the sex-specific 95th percentile on the Centers for Disease Control and Prevention 2000 body mass index-for-age growth charts were considered obese.³⁰

STATISTICAL ANALYSIS

Statistical analyses were conducted using SAS version 9.2 (SAS Institute Inc) and SAS-callable SUDAAN version 10 (Research Triangle Institute). SUDAAN was used to adjust for the complex sample design, and the estimation of standard errors was performed by Taylor series linearization. Data were analyzed using sample weights to account for differential probabilities of selection, nonresponse, and noncoverage. Sample weights can be considered as measures of the number of persons represented by the particular sample observation and are required to produce nationally representative estimates.³¹

The prevalence of adherence to recommendations was calculated by age, sex, race/ethnicity, FIPR, head-of-household education level and marital status, and obesity status. Differences

Table 1. Data on Children Who Met Physical Activity or Screen-Time Recommendations or Both in the 2009-2010 NHANES

Variable	Sample Size	Children, % (SE)		
		Physical Activity ^a	Screen-Time Viewing ^b	Both
Overall ^c	1218	70.4 (2.3)	53.5 (2.6)	38.3 (2.0)
Age group, y				
6-8	609	76.1 (3.2)	59.1 (2.8)	45.5 (2.3)
9-11	609	64.7 (2.6)	47.8 (3.7)	31.1 (3.3)
Sex				
Male	620	73.3 (2.7)	52.7 (3.1)	38.7 (2.6)
Female	598	67.3 (2.6)	54.3 (2.5)	37.9 (2.0)
Race/ethnicity				
Hispanic	502	65.7 (4.4)	61.7 (3.0)	40.6 (3.3)
Non-Hispanic white	391	73.4 (2.6)	55.4 (3.7)	41.2 (3.0)
Non-Hispanic black	241	72.5 (3.8)	36.7 (4.8)	26.3 (3.6)
Income ^d				
<130% FIPR	512	74.4 (3.6)	50.7 (3.1)	39.2 (2.8)
130%-349% FIPR	386	68.9 (2.8)	53.8 (4.5)	38.3 (3.2)
≥350% FIPR	224	65.3 (4.5)	58.4 (2.7)	38.2 (3.9)
Head-of-household education level ^d				
<High school	354	67.7 (4.7)	49.9 (3.3)	35.8 (3.8)
High school	279	74.2 (4.8)	55.3 (6.3)	44.8 (6.9)
>High school	537	70.0 (3.1)	54.1 (3.1)	37.0 (2.5)
Head-of-household marital status ^d				
Married or living with a partner	865	70.5 (2.5)	56.5 (2.7)	40.7 (1.9)
Single	340	70.2 (3.5)	44.7 (4.6)	31.2 (3.8)
Obesity status ^{d,e}				
Obese	246	57.5 (3.3)	44.2 (3.6)	26.5 (3.3)
Not obese	963	73.3 (2.4)	55.4 (2.8)	40.9 (2.1)

Abbreviations: FIPR, family income to poverty level ratio; NHANES, National Health and Nutrition Examination Survey.

^aGuidelines for physical activity: 60 min/d or more, 7 d/wk, of moderate-to-vigorous physical activity.

^bGuidelines for screen-time viewing: 2 h/d or less.

^cIncludes racial/ethnic groups not shown separately.

^dSubgroup sample sizes do not add up to the total sample size because of missing data.

^eChildren at or above the sex-specific 95th percentile on the Centers for Disease Control and Prevention 2000 body mass index-for-age growth charts were considered obese.

in adherence to recommendations were examined using multiple logistic regression models. All covariates in the multiple logistic regression models were included as categorical variables. Adjusted odds ratios (aORs) and 95% CIs of meeting recommendations were calculated. The *P* values from the Satterthwaite-adjusted *F* statistic are also presented. *P* < .05 was considered statistically significant.

RESULTS

Our analysis included 1218 children 6 to 11 years of age who participated in both the in-home interview and the physical examination portions of the survey. Sample sizes by demographic characteristics are shown in **Table 1**.

The distributions of responses to the physical activity question, the TV- or video-viewing question, and the out-of-school computer use question are shown in our **Figure**. Based on proxy reports, the majority of children were physically active for at least 60 minutes each day of the week, whereas only 3% were not active for 60 minutes on any day of the week (Figure, A). For screen time, the majority of children did not use a computer or play computer games outside of school in the last 30 days; however, almost a third of children watched TV or videos for an average of 2 hours per day in the past month (Figure, B).

The prevalence of adherence to recommendations by demographic characteristics is shown in Table 1. In 2009-2010, a mean (SE) 70.4% (2.3%) of school-aged children met physical activity recommendations, and a mean (SE) 53.5% (2.6%) met screen-time recommendations, whereas only a mean (SE) 38.3% (2.0%) met both recommendations concurrently.

Differences in adherence to physical activity recommendations by demographic characteristics and obesity status were examined using logistic regression models (**Table 2**). The odds of meeting recommendations were significantly lower for children 9 to 11 years of age compared with those 6 to 8 years of age (aOR, 0.60 [95% CI, 0.42-0.86]). Girls (aOR, 0.68 [95% CI, 0.51-0.92]), Hispanics (aOR, 0.60 [95% CI, 0.38-0.95]), children in households with an income 130% to 349% of the poverty line (aOR, 0.59 [95% CI, 0.35-0.99]), and those in households with an income 350% or more of the poverty line (aOR, 0.46 [95% CI, 0.26-0.81]) were less likely to meet physical activity recommendations compared with boys, non-Hispanic whites, and those living in households with an income below 130% of the poverty line, respectively. In addition, obese children had lower odds of adherence to physical activity recommendations when compared with their nonobese counterparts (aOR, 0.44 [95% CI, 0.32-0.60]). The odds of meeting physical activity rec-

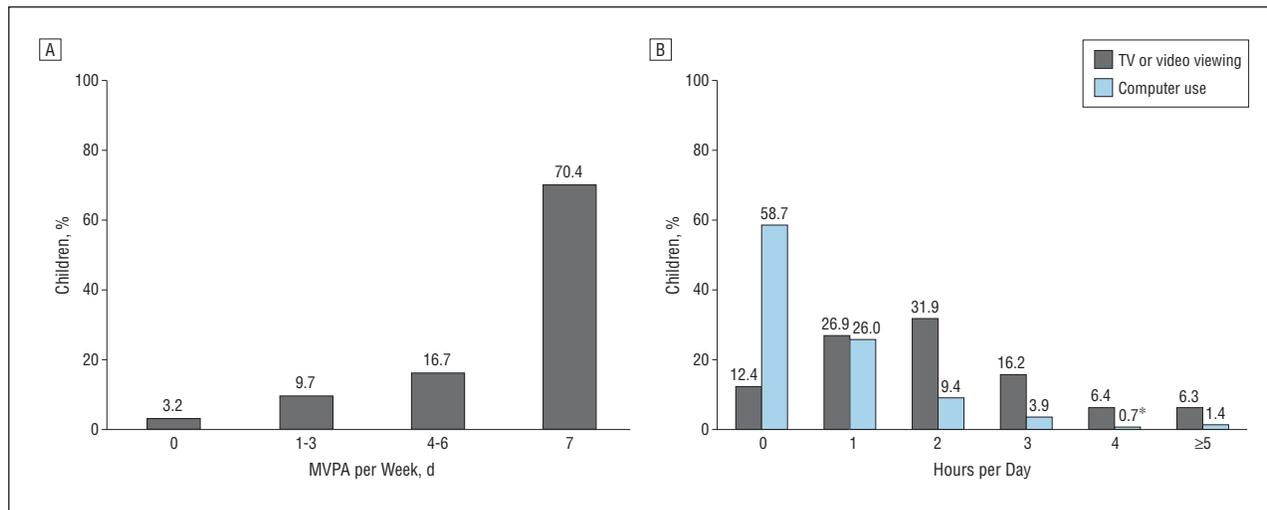


Figure. Distributions of responses to questions about physical activity, television (TV) or video viewing, and computer use. The percentage of children with proxy-reported number of days (ie, 0, 1-3, 4-6, or 7 days) of 60 minutes or more of moderate-to-vigorous physical activity (MVPA) per week (A) and the percentage of children with proxy-reported number of hours per day (ie, <1, 1, 2, 3, 4, or ≥5 h/d) of TV or video viewing or computer use are shown. *Does not meet standard of statistical reliability and precision (relative SE of ≥30% but <40%).

Table 2. Logistic Regression Analysis of Meeting Recommendations in the 2009-2010 NHANES

Variable	Physical Activity ^a		Screen-Time Viewing ^b		Both	
	aOR (95% CI)	P Value	aOR (95% CI)	P Value	OR (95% CI)	P Value
Age group, y						
6-8	1 [Reference]		1 [Reference]		1 [Reference]	
9-11	0.60 (0.42-0.86)	.008	0.61 (0.42-0.89)	.013	0.57 (0.38-0.85)	.009
Sex						
Male	1 [Reference]		1 [Reference]		1 [Reference]	
Female	0.68 (0.51-0.92)	.015	1.15 (0.90-1.48)	.24	0.98 (0.79-1.22)	.85
Race/ethnicity						
Non-Hispanic white	1 [Reference]		1 [Reference]		1 [Reference]	
Non-Hispanic black	0.93 (0.54-1.60)	.79	0.57 (0.34-0.94)	.030	0.61 (0.36-1.05)	.07
Hispanic	0.60 (0.38-0.95)	.031	1.69 (1.18-2.43)	.007	1.06 (0.70-1.60)	.78
Income						
<130% FIPR	1 [Reference]		1 [Reference]		1 [Reference]	
130%-349% FIPR	0.59 (0.35-0.99)	.046	1.10 (0.67-1.80)	.68	0.81 (0.58-1.12)	.19
≥350% FIPR	0.46 (0.26-0.81)	.010	1.32 (0.78-2.23)	.29	0.79 (0.49-1.28)	.31
Head-of-household education level						
<High school	0.78 (0.53-1.16)	.20	0.86 (0.48-1.53)	.58	0.92 (0.51-1.63)	.75
High school	1.13 (0.49-2.58)	.77	1.15 (0.62-2.13)	.64	1.35 (0.67-2.71)	.38
>High school	1 [Reference]		1 [Reference]		1 [Reference]	
Head-of-household marital status						
Married or living with a partner	1 [Reference]		1 [Reference]		1 [Reference]	
Single	0.95 (0.62-1.46)	.80	0.71 (0.39-1.30)	.25	0.71 (0.42-1.21)	.19
Obesity status ^c						
Obese	0.44 (0.32-0.60)	<.001	0.65 (0.48-0.88)	.009	0.53 (0.38-0.73)	.001
Not obese	1 [Reference]		1 [Reference]		1 [Reference]	

Abbreviations: aOR, adjusted odds ratio; FIPR, family income to poverty level ratio; NHANES, National Health and Nutrition Examination Survey.

^aGuidelines for physical activity: 60 min/d or more, 7 d/wk, of moderate-to-vigorous physical activity.

^bGuidelines for screen-time viewing: 2 h/d or less.

^cChildren at or above the sex-specific 95th percentile on the Centers for Disease Control and Prevention 2000 body mass index-for-age growth charts were considered obese.

ommendations did not differ between those who met and those who failed to meet screen-time recommendations (data not shown).

The odds of meeting screen-time recommendations differed by age, race/ethnicity, and obesity status (Table 2). As with physical activity, children 9 to 11 years of age had lower odds of adherence to screen-time recommen-

dations compared with children 6 to 8 years of age (aOR, 0.61 [95% CI, 0.42-0.89]). The odds of meeting recommendations were lower in non-Hispanic blacks (aOR, 0.57 [95% CI, 0.34-0.94]) but higher in Hispanics (aOR, 1.69 [95% CI, 1.18-2.43]), compared with non-Hispanic whites. Obese children were less likely to meet recommendations compared with nonobese children (aOR, 0.65

[95% CI, 0.48-0.88]). Separate from computer use, the odds of watching TV and videos for 2 hours or less were lower for children 9 to 11 years of age compared with those 6 to 8 years of age (aOR, 0.66 [95% CI, 0.45-0.97]), and for non-Hispanic black children compared with non-Hispanic whites (aOR, 0.46 [95% CI, 0.30-0.72]) (data not shown).

There were fewer differences between groups in meeting both physical activity and screen-time recommendations concurrently compared with meeting the recommendations separately. The only differences were between age groups and between obese and nonobese children. The 9- to 11-year-old children and the obese children were less likely to meet both recommendations concurrently compared with the 6- to 8-year-old children and the nonobese children (children 9-11 years of age: aOR, 0.57 [95% CI, 0.38-0.85]; obese children: aOR, 0.53 [95% CI, 0.38-0.73]).

COMMENT

Based on proxy reports, in 2009-2010, approximately 70% of elementary school-aged children met physical activity guidelines, and about 54% met screen-time viewing guidelines. However, fewer than 4 in 10 children met both recommendations concurrently.

Older children (9-11 years of age) were less likely to meet physical activity and screen-time viewing recommendations compared with children 6 to 8 years of age. Our observations are consistent with a large number of studies that have reported a decline in physical activity levels with age^{21,32-36} and an increase in screen-based sedentary behaviors during childhood.^{23,37} For example, using data from the 2001-2006 NHANES, Sisson et al²³ showed that the proportion of children exceeding 2 hours of daily screen-time viewing increased from 35% of 2- to 5-year-old children to 49% of 6- to 11-year-old children and 56% of 12- to 15-year-old children.

In our study, girls were less likely to meet physical activity guidelines compared with boys. Previous studies,^{20,21,32} based on objective and reported measures of physical activity, have consistently shown boys to be more physically active than girls. However, we did not observe significant differences by sex in adherence to screen-time recommendations. Previous analyses of NHANES data showed that sex was only weakly correlated with screen-time viewing.^{20,23} For example, Sisson et al²³ showed that 49.4% of boys and 45.0% of girls exceeded 2 hours of daily screen-time viewing in 2001-2006, whereas in our analysis, 47.3% of boys and 45.7% of girls exceeded 2 hours of daily screen-time viewing.

Previous research has described differences in physical activity and sedentary behaviors by race and ethnicity. Using objectively measured data from the 2003-2004 NHANES, Troiano et al²¹ reported that 6- to 11-year-old Mexican American boys did not differ from other racial/ethnic groups in their physical activity levels; however, Mexican American girls were less active than non-Hispanic black girls. Studies of reported physical activity and screen time have observed lower physical activity levels in Mexican American children^{20,38} and higher

levels of screen time in non-Hispanic blacks compared with non-Hispanic whites.²⁰ Consistent with these observations, Hispanics were less likely to meet physical activity recommendations in our analyses, whereas non-Hispanic blacks were less likely to meet screen-time recommendations compared with non-Hispanic whites.

Although Hispanics were less likely to meet the physical activity guidelines in our study, they were more likely to meet screen-time recommendations compared with non-Hispanic whites. These results suggest that screen-time viewing and physical activity may be separate constructs and that low levels of screen-time viewing do not necessarily predict higher levels of physical activity. In agreement, the odds of meeting physical activity guidelines did not differ between those who met and those who failed to meet screen-time recommendations (data not shown). Our findings are consistent with published studies from other countries.³⁹⁻⁴³ For example, a cross-sectional study⁴³ of Canadian adolescents found no association between reported physical activity levels and the amount of time spent in screen-based sedentary behaviors. In addition, a study⁴⁰ of European youth also found no association between accelerometer-measured MVPA and the amount of time spent watching TV and showed that TV viewing and physical activity may be differently associated with adiposity and metabolic risk. Using data from a large prospective cohort of US children and adolescents, Taveras et al showed that TV viewing was not associated with changes in MVPA and suggested that "clinical and public health programs should consider television viewing reduction and physical activity promotion as 2 separate foci of behavior change interventions."^{44(p318)}

In our analysis, family income was associated with proxy-reported physical activity. The odds of meeting physical activity recommendations were lower in children living in households with higher vs lower income. An inverse association between income and physical activity has been previously reported. Using 2001-2004 NHANES data, Anderson et al²⁰ reported that higher income was associated with increased likelihood of reduced active play (defined as reported MVPA of <7 d/wk) in children 4 to 11 years of age.

Obese children were less likely to meet physical activity and screen-time recommendations. However, because our analysis is cross-sectional, we are unable to infer causality. Although obesity has been partially attributed to physical inactivity,⁴⁵ recent longitudinal analysis by Metcalf et al⁴⁶ suggests that physical inactivity may be the result of obesity.

In the 2009-2010 NHANES, physical activity of children 6 to 11 years of age was assessed via proxy reports only. Social desirability may lead parents to overreport the number of days of physical activity, which may bias our estimates.⁴⁷ In addition, the accuracy of proxy reports may differ substantially depending on the amount of time spent with the child. For example, parents may not be able to report their child's physical activity while at school. Despite these limitations, proxy reports of physical activity of young children may be more accurate than self-reports because young children are unable to recall accurately the length of time spent in physical activ-

ity.⁴⁸⁻⁵⁰ Consequently, many researchers do not recommend the use of self-reports for physical activity time among children younger than 10 years of age.^{47,49}

Although objectively measured physical activity using an accelerometer may circumvent issues related to proxy reporting, accelerometers have their limitations, especially when used to measure the physical activity of young children. The use of numerous intensity cutoff values and different epoch lengths (time-sampling intervals) has led to large differences in estimates of adherence to physical activity guidelines.^{26,51,52} In addition, conventional accelerometers may fail to adequately capture certain movements such as swimming, cycling, and climbing, which may lead to an underestimation of total physical activity. This may explain some of the difference between our adherence prevalence estimates (about 70% of 6- to 11-year-old children meet physical activity recommendations) and those assessed by an accelerometer in the 2003-2004 NHANES (about 42% of 6- to 11-year-old children meet physical activity recommendations).¹⁸ Because of these measurement issues, many researchers and physical activity experts are now advocating for the use of multiple methods to assess physical activity accurately. Finally, surveillance of physical activity on a population level using an accelerometer is expensive and logistically complex, whereas reported physical activity is less expensive and less burdensome in large population studies.

In summary, our analysis of the most recent national data showed that, although the majority of school-aged children met physical activity and screen-time recommendations separately, fewer than 4 in 10 children met both recommendations concurrently in 2009-2010. Our results also suggest that low levels of screen time do not necessarily predict higher levels of physical activity. Nonetheless, both were independently associated with obesity status. These findings support the distinct recommendations for screen-time viewing and physical activity by the American Academy of Pediatrics^{2,17-19} and may inform interventions designed to prevent childhood obesity, such as the First Lady Michelle Obama's program to end childhood obesity within a generation (ie, the Let's Move! initiative).⁵³ Future research from longitudinal studies may further clarify the association between physical activity, screen-time viewing, and obesity.

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