



RESEARCH REVIEW

January 2014

Sedentary Behaviors and Youth: Current Trends and the Impact on Health

ABSTRACT

National guidelines recommend at least 60 minutes of moderate-to-vigorous physical activity every day for children and teens, but the majority of young people do not meet that goal. Spending excessive time engaging in sedentary behaviors, such as watching TV, playing video games, and other screen time activities, contributes to the problem.¹ Sedentary behaviors are linked with higher risk for obesity, diabetes, and other chronic health problems among adults, even among those who are physically active and have healthy diets.²⁻⁶

This review examines trends in sedentary behaviors among youth and their impact on obesity. It also explores differences in the prevalence of sedentary behaviors based on age, gender, race, ethnicity, and socioeconomic status.

Research shows the amount of time young people spend in sedentary behaviors has increased in recent years, and while this includes TV time, it is a dramatic increase in other types of screen time, such as computers and video games, that appears to be driving the trend.⁷ There also has been an increase in the percentage of kids who spend an excessive amount of time (2 or more hours per day) in sedentary behaviors. A number of studies link TV viewing with increased risk for overweight and obesity among children and teens.^{8, 9-14} Efforts to reverse the nation's childhood obesity epidemic should include a focus on reducing kids' sedentary time, especially time spent viewing TV.

INTRODUCTION

Childhood obesity is one of the most urgent threats to the health of our children and families.¹⁵ Nearly one-third of all children and adolescents in the United States are overweight or obese, and rates among African American and Latino children, as well as children living in lower-income households, are even higher.¹⁵ Obesity is associated with many serious health problems during childhood^{16–19} and creates lifetime risks for cardiovascular disease, stroke, asthma, and some cancers.¹⁹

To prevent obesity and promote health among children, the American Academy of Pediatrics and other experts recommend a nutritious diet, regular physical activity, and limits on screen time, including TV viewing, video games, leisure-time computer use, and other screen-based activities that contribute to sedentary behaviors.

In recent years, there has been growing concern about the excessive amount of time many young people spend in sedentary behaviors (activities done in a sitting or reclining posture, e.g., watching TV). Youth who are sedentary have greater fat mass, higher body mass index (BMI), and greater risk of being overweight or obese, regardless of how much physical activity they get when not being sedentary.^{8, 12, 14}

There is also evidence that watching more TV impacts children's health as they grow older.⁸ For example, children and teens who spend more than two hours per day watching TV are more likely to be overweight, have higher cholesterol levels, smoke, and have poor fitness as adults.¹

Most of the evidence about the impact of sedentary behaviors on children's health is based on studies of TV time.^{8, 14} Importantly, watching TV is also linked with unhealthy eating.¹² The association between TV time and overweight and obesity among youth may be due to a number of factors, including unhealthy eating, the biological effects of sitting, spending less time being physically active, or some combination.^{23, 24} Sedentary time can also impact aspects of children's well-being beyond just their health. Young people who spend excessive time in sedentary behaviors also are more likely to have lower academic achievement,^{8, 20} poorer motor skills,²¹ and lower quality of life.²²

Understanding trends in sedentary behaviors among children and teens and the related disparities will help inform efforts to reduce sedentary time among youth.

METHODS

This review is based on evidence gathered using PubMed and Google Scholar on the relation of sedentary behaviors to overweight and obesity, and the prevalence and correlates of sedentary behaviors. The emphasis is on understanding sedentary behaviors among low-income and high-risk ethnic/racial populations and communities, with a focus on African American and Latino populations. Article titles and abstracts were examined, and relevant articles were retrieved. Additional articles were identified through searches of the references of the initial set of publications. Position papers from organizations, such as the American Academy of Pediatrics, were also reviewed. Search limits were confined to the English language. Searches were not restricted by country of origin, date or study design.

Defining Sedentary Behavior

Sedentary behavior consists of behaviors occurring during waking hours that have a very low level of energy expenditure, such as sitting or lying down.^{25, 26} Sedentary behaviors can consist of leisure-time activities (e.g., TV viewing; playing video games; leisure-time computer use) or sitting during school or work time.^{27, 28}

Spending too much time in sedentary behaviors differs from not getting enough physical activity. In other words, being too sedentary is distinct from not meeting physical activity guidelines.^{28, 29} The American Academy of Pediatrics recommends that parents limit school-age children's total media time (watching TV or videos and playing video games) to two hours per day.³⁰ For children under 5 years of age, time spent being sedentary outside of napping or resting should be no more than one hour per day, and none of this time should be spent watching TV or in other screen-based activities for children under 2 years of age.^{31, 32} Research seems to indicate that the physiological benefits from reducing sedentary time are distinct from those of increasing moderate-to-vigorous physical activity, thereby making the reduction of sedentary behavior an important target of health intervention in its own right.³³

Two main ways to assess sedentary behavior are with self-reports (i.e., surveys) or devices (most often accelerometers). Surveys can be used to determine whether the person is watching TV, using a computer, or riding in car.²⁸ Devices provide objective data on the amount of time spent at low energy levels, but they cannot distinguish between different domains (e.g. home, work, school) or types (e.g., watching TV, reading) of sedentary behavior the way surveys can. Studies in the past have not been able to properly assess the duration of sitting due to lack of

instruments that can capture body posture. Only recently have researchers been able to start measuring posture using objective and valid measures.³⁴

Seven review papers were found addressing either the role of sedentary behaviors in weight and/or the correlates of sedentary behaviors.^{8, 12, 35–39} The majority of studies were based on self-reported sedentary behavior, few of which reported validity or reliability data for the instruments used. The self-reported evidence pertained mostly to TV time, with some on other screen time (e.g., video games, computers). Very little evidence was found on sedentary behaviors measured comprehensively, as few tools are able to assess sedentary behaviors occurring throughout the day.²⁸

This review focuses on sedentary behaviors among children and adolescents, but includes evidence on adults when relevant. The 2008 National Physical Activity Guidelines defines children as younger than 11 years and adolescents as 12 to 17 years.⁴⁰ This review uses those definitions and defines youth as including children and adolescents. However, studies varied in the age ranges used in categorizing children, adolescents and youth.

KEY RESEARCH RESULTS

- 1. Sedentary behavior, primarily assessed as time spent viewing TV, increases risk for overweight and obesity in childhood and adolescence.**
- 2. Children and adolescents spend an average of 6 and 8 hours per day, respectively, in sedentary behaviors, both during and outside of school.**
- 3. The amount of time children and adolescents spend daily in sedentary activities, and the percentage of youths engaging in excessive sedentary time, both increased in recent years. A dramatic increase in screen time, which includes new ways to consume TV content, appears to be driving the increase in kids' sedentary time.**
- 4. African American children report spending more time in sedentary behaviors than do White children, and children from lower-income families report more sedentary time than children from more affluent families, but those disparities are not evident in studies based on objective measures.**
- 5. Older children and teens are more likely to spend more time in sedentary behaviors and to exceed recommended limits on sedentary time than younger children.**

- 6. The evidence on whether girls or boys are more sedentary is mixed. Objective data revealed teenage girls are more sedentary than teenage boys, but surveys indicated boys spend more time playing video games.**
- 7. Children who do not have limits on screen time and live in homes with multiple TVs and TVs in bedrooms are at greater risk for sedentary behavior.**

STUDIES SUPPORTING KEY RESEARCH RESULTS

Key Result 1: Sedentary behavior, primarily assessed as time spent viewing TV, increases risk for overweight and obesity in childhood and adolescence.

TV Watching and Weight

Three reviews found being sedentary (primarily measured as TV viewing) was related to an increased risk among children and adolescents of being overweight.^{8, 12, 14} For example, a meta-analysis of 232 studies of youth ages 5 to 17 found considerable evidence that watching more than two hours of TV per day was associated with a higher risk of being overweight.⁸ Also, 94 of the 119 cross sectional studies in this meta-analysis showed more time spent watching TV was associated with a higher risk of having unhealthy body composition and BMI.⁸

Many individual cross-sectional studies found excessive TV viewing was related to a higher risk of overweight or obesity in children and adolescents.^{7, 41–44} A large national study (n=46,707) showed children who watched TV for three or more hours daily had a 65 percent higher chance of being obese than children who spent less than one hour watching TV daily (Figure 1).⁴¹ In another national study (n=2,000), children who watched TV for three or more hours daily were 48 percent more likely to be obese than children who watched TV for less than one hour daily.⁷

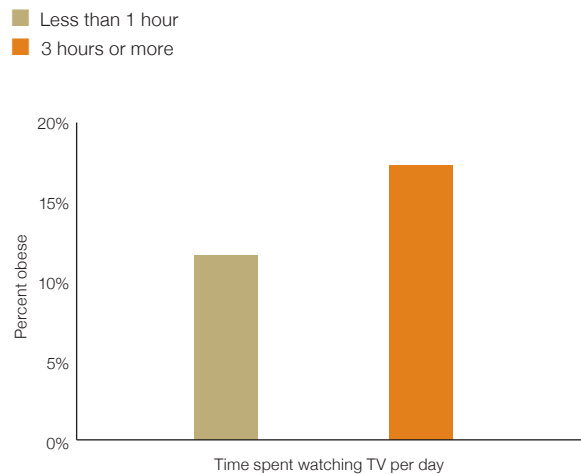
There may also be racial/ethnic and socioeconomic differences in the link between sedentary behaviors and obesity. A survey of 3,596 youth aged 14 to 18 years revealed TV viewing, playing video games, and computer use put African American youth, but not their White peers, at elevated risk for obesity.⁴⁵

TV as a Risk Factor over Time

Prospective studies provided stronger evidence on TV's role as a risk factor for obesity in youth. Several studies indicated a link between time spent watching TV during childhood with weight gain, obesity, and BMI increases later in life.^{8, 12, 20, 36} A meta-analysis found evidence in 19 longitudinal studies

that spending more than two hours per day watching TV was related to steeper increases in BMI, body weight, and fat mass over time.⁸

FIGURE 1 Children Who Watch More TV Are at Higher Risk of Obesity⁴¹



An international review provided clear evidence of TV viewing increasing children's and adolescents' risk for weight gain and obesity as they grew older.³⁶ Two of the three longitudinal studies included in this review found a dose-response association between more TV viewing time and increasing likelihood of becoming overweight. One study showed that with each additional hour of TV watched on weekends at age 5, there was a 7 percent increase in risk of being obese at age 30.⁴⁶ The other longitudinal study, which examined TV time during weekdays, found more time spent watching TV between ages 5 and 15 predicted higher BMI and cholesterol levels at age 26.²⁰

This risk over time may be independent of physical activity. A national study following adolescents into young adulthood (n=9,155) found the risk of being obese later in life lower among those who had low versus high weekly screen time (7 hours versus 25 hours), regardless of physical activity. Low screen-time was associated with a 40 and 20 percent reduction in obesity risk in young adulthood for females and males, respectively.⁴⁷

TV Watching versus Total Sedentary Time

There were different possible explanations for why excessive time spent being sedentary (measured mainly as TV viewing and other screen time) was related to weight and obesity. It has been proposed that sedentary activities may displace time for being physically active. There was some evidence

to support this hypothesis.^{41, 48} However, several studies indicated TV viewing was associated with an elevated risk of being overweight or obese, even when children were active.⁴²⁻⁴⁴ Thus another possibility is the sedentary nature of TV viewing explains the relationship of TV time to obesity risk.

Although many studies found TV time was related to a higher risk of obesity and cardiometabolic risk factors (e.g., BMI and abdominal adiposity) even among physically active youth, a review concluded total time spent being sedentary was not associated with any cardiometabolic risk factors independent of time spent in moderate-to-vigorous physical activity.⁹ This review examined 14 objective studies (both cross-sectional and prospective) from multiple countries (total n=20,871 children aged 4 to 18 years). Thus, it appears from current evidence that overall sedentary time is not a risk factor for obesity, and the sedentary nature of TV time may not be the main pathway linking TV viewing and obesity. This suggests some other factor, such as unhealthy eating, explains why TV is associated with higher BMI.

TV and Eating

TV watching may contribute to obesity risk by influencing the amount and types of foods and beverages consumed. Many studies demonstrated a relationship between TV viewing and unhealthy diets.^{11, 49-53} In a review of 53 studies, screen-based sedentary behavior (primarily TV) was associated with lower consumption of fruits and vegetables and higher consumption of high calorie snacks, drinks, and fast food in both children and adults.¹¹ Nationally representative data from children age 6 to 11 (n=1749) showed children who watched less TV ate healthier diets. Compared with children who watched four or more hours of TV per day, children who watched less than an hour per day ate more fruits, vegetables, and legumes, and less saturated fat, sodium, and added sugars.⁴⁹ According to another study, for every hour of TV children watched, they were 8 percent less likely to eat fruit every day, 18 percent more likely to eat candy, and 16 percent more likely to eat fast food.⁵⁰

TV watching during childhood and adolescence can also impact eating behaviors later in life. One study tracked the TV viewing habits and change in BMI of 1,100 young children and found the more daily hours of TV children watched at the start of the study, the more likely they were to have an increase in BMI five years later.⁵⁴

Longitudinal data revealed Australian adolescents (n=1,729) who watched more than two hours of TV per day ate more energy-dense snacks and drinks and consumed less fruit two years later than did peers who spent less time watching TV.⁵¹

Because of the consistent evidence of an association between TV and diet, it was not clear whether the eating or sedentary behavior component of TV viewing was most responsible for the obesity risk.

Findings from a longitudinal study (n = 1,100) suggested exposure to food advertising may partially account for the obesity risk associated with TV viewing. Each additional hour of commercial TV children viewed at the start of the study was significantly associated with a 0.11 increase in BMI five years later. No increase in BMI was found to be associated with watching non-commercial TV.⁵⁴

TV and Youth Obesity: The Reason is Unclear

Though it is clear TV was related to unhealthy eating, no direct evidence was found showing that unhealthy eating fully explained the link between TV time and obesity. Research suggests that TV viewing could play a special role in obesity, but it is not clear whether it is the time spent being sedentary, the unhealthy eating, or a combination, that is responsible for the obesity effect.

Key Result 2: Children and adolescents spend an average of 6 and 8 hours per day, respectively, in sedentary behaviors, both during and outside of school.

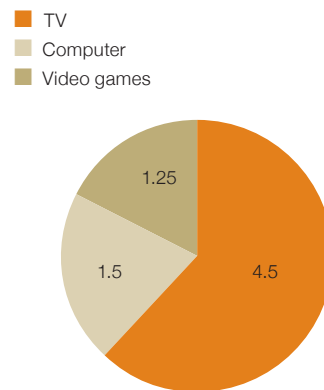
Research shows a high prevalence of both leisure-time and overall sedentary behavior among children and adolescents. Across the country, children and adolescents spent an average of 6 and 8 hours per day, respectively, in total sedentary time as measured by electronic accelerometers worn on the waist.⁵⁵ Even very young children were at risk for engaging in too much sedentary behavior. The American Academy of Pediatrics (AAP) recommends 0- to 2-year olds watch no TV and that 3- to 4-year olds watch no more than two hours per day.³⁰ But a national survey of 1051 parents revealed 68 percent of children aged 0 to 2 years and 44 percent of children aged 3 to 4 years exceeded the AAP recommendations.⁵⁶

Several studies using nationally representative self-reported data showed an excess of TV viewing and other screen-based leisure-time sedentary behaviors (watching videos or playing video games) among children and adolescents.^{7, 48, 57, 58} In the largest study (n = 68,288), 17 percent of youth aged 6 to 17 years watched three or more hours of TV per day. On an average school day, 32.4 percent of adolescents watched TV for three or more hours and 31.1 percent played video games or used a computer for leisure for three or more hours.⁵⁸ In another large study of youth aged 6 to 17 years (n = 53,562),

44 percent spent at least two hours per day watching TV or videos or playing video games.⁴⁸

Smaller studies also found a high prevalence of screen-based sedentary behaviors. A survey of 8,707 children ages 2 to 15 showed 47.3 percent of children spent two or more hours daily on TV and video viewing and computer use.⁵⁷ And in a report conducted by the Kaiser Family Foundation (n = 2,000 children aged 8 to 18 years), children spent an average of 4.5 hours watching TV, 1.5 hours using the computer, and 1.25 hours playing video games daily (Figure 2).⁷

FIGURE 2 Average Hours Children and Adolescents Spent Daily Using Different Media in 2009⁷



Analysis of national accelerometer data found total sedentary time was six hours per day among 6 to 11 year old children and eight hours daily among youth aged 16 to 19 years.⁵⁵ In contrast to research based on self-reports of specific behaviors, accelerometer results showed youth spent twice as much time in sedentary behaviors. The findings suggest media use accounts for only half of the overall time spent sedentary.

Key Result 3: The amount of time children and adolescents spend daily in sedentary activities, and the percentage of youths engaging in excessive sedentary time, both increased in recent years. A dramatic increase in screen time, which includes new ways to consume TV content, appears to be driving the increase in kids' sedentary time.

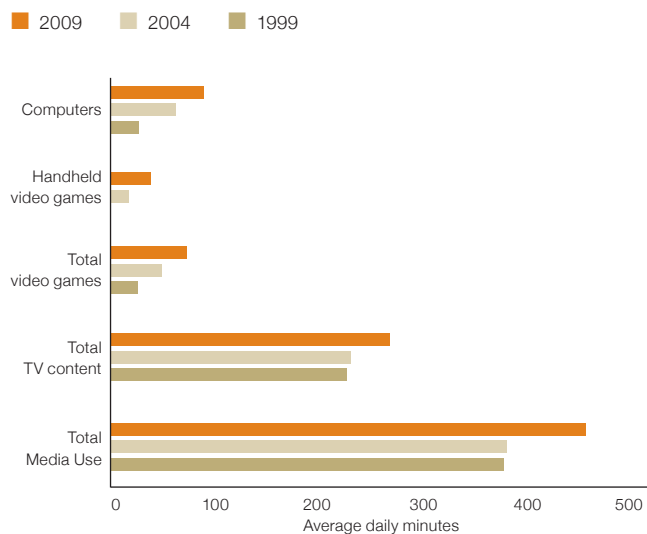
The amount of time children spend watching TV in its traditional format, i.e., viewing regularly scheduled programming on a TV monitor, has not increased much. A U.S. time-use survey showed children ages 9 to 12 in 2003 spent only 6 percent more time watching TV than this age group spent in 1997.⁵⁹ A Kaiser Family Foundation report on youth

ages 8 to 18 actually found a 13.5 percent *decrease* in time spent watching regularly scheduled programming on a TV set between 1999 and 2009.⁷ However, this same report showed an increase of 18.5 percent in the amount of total TV content children consume each day during this same period, due in large part to the proliferation of various forms of new media with which to consume TV content in recent years, including laptops, tablets, and mobile phones.

This proliferation of new media forms contributed to the increase in time spent in other screen-based sedentary activities, including playing video games and recreational computer use (e.g., surfing the Internet, reading magazines/newspapers online). Between 2004 and 2009, children increased the total amount of time they spent each day playing video games (i.e., on consoles and handheld devices) by 49 percent.⁷ The growing popularity of playing video games on mobile phones, tablets, and other handheld devices largely fueled the dramatic increase in time spent playing video games. In this same time period, the amount of time spent playing video games on handheld devices more than doubled.⁷

Recreational computer use was another major factor in driving up sedentary time. The average time spent each day using a computer jumped from 62 minutes in 2004 to 89 minutes in 2009 — a 43.5 percent increase. Overall, total media use from 2004 to 2009 increased by 20.2 percent.⁷ For a breakdown of increases in minutes spent in different screen-based activities, see Figure 3.

FIGURE 3 Minutes Spent in Different Screen-Based Activities Each Day⁷



Along with increases in the amount of time children spent in screen-based sedentary activities, there has been a rise in the prevalence of children who engage in too much screen time (e.g., watching TV/videos and/or playing video games for 2 or more hours daily). According to a large national survey, the percentage of U.S. children aged 6 to 18 years who engaged in two hours daily of screen time rose from 16.4 percent in 2003 to 21.7 percent in 2007— an increase of 32 percent.⁶⁰

In addition to a greater prevalence of excessive screen time, more children are engaged in sedentary forms of transportation, like being driven to school by car. Nationally, the proportion of children traveling to school in cars has more than doubled — jumping from 12 percent in 1969 to 44 percent in 2009.⁶¹ The dramatic rise in children being driven to school is also evident in other countries. In the United Kingdom, the proportion of children ages 5 to 10 being driven to school increased by 59 percent (from 27% to 43%) between 1989–1991 and 2008.⁶² Between 1971 and 2003, the percentage of 5- to 9-year olds who were driven to school nearly tripled in New South Wales, Australia.⁶³

Key Result 4: African American children report spending more time in sedentary behaviors than do White children, and children from lower-income families report more sedentary time than children from more affluent families, but those disparities are not evident in studies based on objective measures.

Children of color and lower-income children have the highest rates of obesity.^{15, 64} National surveys indicated these children also watched significantly more TV.^{7, 65} In one study, White children spent 31 percent and 34 percent less time using electronic media each day than their Hispanic and African American peers, respectively.⁷ A survey of 1,384 parents nationwide on young children’s digital media use (ages 0 to 8) showed African American children spent 56 percent more minutes per day using digital media (TV/video; video games; computers; smart phones) than their White peers.⁶⁶ This same study found children from lower-income families spent 28 percent more minutes per day using digital media compared with children from higher-income families.

One review found higher levels of sedentary behaviors that were both screen-based (e.g., TV watching, computer use, video games), and not screen-based (e.g., talking on the phone, listening to music, studying) among non-White children.⁶⁷ In another review, being non-White was related to more time spent viewing TV but not to other screen-based sedentary behaviors (i.e., video games, computers).¹⁴

When measured objectively, there was little evidence of an association between income status or race/ethnicity and time spent being sedentary. An analysis of objective NHANES data (n=2,531) revealed a high prevalence of sedentary time across all children, with no overall disparities between racial or ethnic groups. Average daily hours spent being sedentary were 5.6 in children and 7.9 in adolescents among Whites, 5.9 in children and 8.3 in adolescents among African Americans, and 5.8 in children and 7.6 in adolescents among Mexican Americans.⁶⁸

The lack of objective evidence showing disparities in total sedentary time may be due in part to a lack of data on time spent riding in a car, a sedentary activity that may be more prevalent among White and higher income children and youth whose families are more likely to own at least one vehicle than among lower-income families. An analysis of National Household Travel Data revealed students from households with no vehicles had a probability of walking or biking to school that was 16 percentage points higher than students from households with at least one vehicle.⁶⁹

Key Result 5: Older children and teens are more likely to spend more time in sedentary behaviors and to exceed recommended limits on sedentary time than younger children.

Several studies demonstrated older children and adolescents were more at risk for spending too much time in sedentary behaviors, compared with their younger peers. Surveys from 1,218 children indicated that children ages 9 to 11 engaged in 23.6 percent more screen time compared with their younger peers ages 6 to 8.⁷⁰ A large nationally representative study (n=17,807) found adolescents (12- to 19-year olds) were 13 percent more likely to be sedentary than young children. Seventy-four percent of adolescents spent two or more hours engaged in screen time, compared with 63.6 percent of 2- to 5-year olds.⁷¹

Similar findings were evident in three smaller cross-sectional studies, also based on national data. Total sedentary time measured with accelerometers (n=6,329) revealed 16- to 19-year olds spent 33.3 percent more time being sedentary than 6- to 11-year olds.⁵⁵ An analysis of self-reported data (n=2,000) sponsored by the Kaiser Family Foundation found 11- to 14-year olds and 15- to 18-year olds spent 58 percent and 45 percent more time, respectively, using electronic media daily than youth ages 8 to 10.⁷

In addition to cross-sectional differences, prospective evidence indicated as children grew older, they increased the amount of time spent being sedentary. A study of 2,516 ethnically diverse adolescents showed substantial changes among boys in the amount of time spent using a computer for leisure each week, with an increase of 33.3 percent between early to mid-adolescence and 36.5 percent from mid-to-late adolescence.⁷² Survey data from 5,287 high school students in the United Kingdom revealed youth were more sedentary between the ages of 15 and 16 than they were between the ages of 11 and 12. There was an average increase in the hours spent watching TV and playing video or computer games each week of 2.5 hours among boys and 2.8 hours among girls.⁷³

Increases in sedentary time continued into adulthood. A nationally representative study (n=13,030) that followed 18 year olds as they aged revealed that 25 percent of adolescents engaged in too much screen time and continued to do so as adults. Among those who met the recommended level of screen time in adolescence, 17 percent increased their sedentary time by age 26. Furthermore, African American youth were more likely to increase their sedentary time as they entered adulthood.⁶⁵

Key Result 6: The evidence on whether girls or boys are more sedentary is mixed. Objective data revealed teenage girls are more sedentary than teenage boys, but surveys indicated boys spend more time playing video games.

Objective data on school-aged children showed girls spent more time engaged in overall sedentary behaviors than did boys. In a national study based on accelerometers, females had more sedentary time than boys across different age groups. This gender gap was most pronounced in adolescents ages 16 to 19, among which females had 5.7 percent more sedentary time than their male peers.⁵⁵ Objective data from five European countries (n=686) found girls spent 26 more minutes being sedentary per day than boys, a significant difference.⁷⁴

In contrast, evidence on preschool-aged children for the most part did not find any gender differences. In North Carolina, accelerometer data revealed girls spent 5.2 percent more time being sedentary than boys.⁷⁵ But a review of 29 studies on preschool aged children from 1993 to 2009 found no clear correlation between sex and sedentary behavior. Six of these studies were based on accelerometer data.³⁷

Self-reported evidence, typically focused on TV viewing and other screen-based activities, generally found girls spent less time being sedentary than boys. In a large national survey (n=46,706), girls were 24 percent less likely than boys to watch TV for 3 or more hours per day.⁴¹ In another national study (n=8,707), girls were 8 percent less likely than boys to spend two or more hours engaged in screen time each day.⁵⁷

Surveys showed boys spent more time than girls using computers, playing video games, and watching videos. A systematic review of 90 English-language studies on adolescents around the world revealed boys were more than three times as likely to play video games in excess of four hours weekly.⁷⁶ Findings from 158 high schools across the country revealed males were 32.7 percent more likely than females to spend more than three hours daily using computers in their leisure time.⁵⁸ In a study of 2,000 children ages 8 to 18, the amount of time boys spent playing video games was four times greater than girls.⁷ Data on 13,293 children ages 11 to 18 in Mexico showed boys spent 12.5 percent more of their overall screen watching videos and playing video games than did girls. Also, when examining video viewing and video game playing separately from TV time, more time spent watching videos and playing video games was related to higher BMI among boys, but not girls.⁷⁷

Key Result 7: Children who do not have limits on screen time and live in homes with multiple TVs and TVs in bedrooms are at greater risk for sedentary behavior.

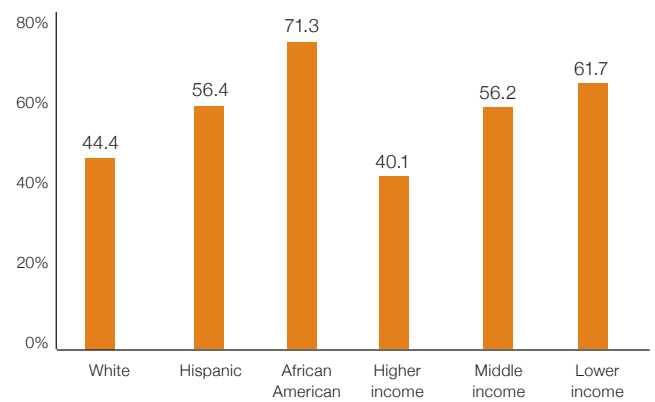
A sizeable body of research demonstrated associations between the home media environment and amount of time children and adolescents spent in sedentary behaviors.^{14, 29, 38, 78} A review indicated children from households with more access to TVs or computers were more sedentary, and children in homes with rules and limitations on screen time were less sedentary.²⁹ Two other reviews found children who have a TV in the bedroom had a higher prevalence of TV viewing.^{14, 38}

Across the country, youth living in homes where the TV was on most of the time were at greater risk of being sedentary.⁷ According to one survey (n=2,000), children and adolescents living in homes where the TV was left on most of the time spent nearly twice as much time watching TV than did youth in homes where the TV was on little to none of the time.⁷ In another study (n=1,051), children ages 3 to 4 living in households where the TV was on constantly were twice as likely to watch more than two hours of TV per day than their peers living in homes where the TV was not on all

the time.⁵⁶ When parents imposed rules limiting media use, children averaged 29 percent less time exposed to media than their peers without such parental rules.⁵⁶

According to one national survey, nearly half of children ages 6 to 17 had a television in their rooms, with an even higher prevalence among African American, Hispanic, and low-income families (Figure 4).⁷⁹

FIGURE 4 Prevalence of TV in Children's Bedrooms in 2007, by Race/Ethnicity and Income⁷⁹



TVs were also common in the bedrooms of infants and toddlers. In a national survey of 1,384 parents, 29 percent of children ages 6 to 23 months, and 44 percent of children ages 2 to 4 years, had a TV in their bedrooms.⁶⁶ This survey also found lower-income families were more than twice as likely than affluent ones to have TVs in their children's bedrooms.

Having TVs in bedrooms was associated with more screen time among children^{42, 80} and adolescents.^{7, 38} A national survey of 8- to 18-year olds found those with TVs in their bedrooms watched 56 percent more TV daily compared with peers without TVs in their bedrooms.⁷

Children with TVs in their bedrooms had a greater likelihood of being overweight. Nationally, children with TVs in their bedrooms were 44 percent more likely to be overweight compared with peers without bedroom TVs. This association existed regardless of amount of time spent viewing TV.⁷⁹ A smaller cross-sectional study (n=2,343) found children ages 9 to 12 with TVs in their rooms were 32 percent more likely to be overweight, regardless of how often they watched TV or movies or used the internet.⁸¹

CONCLUSIONS AND POLICY IMPLICATIONS

More and more young people are spending an excessive amount of time in sedentary behaviors. On average, children and teens spend 6 to 8 hours per day watching TV, playing video games, and using computers. Relatively strong evidence links TV viewing with obesity, as well as increased fat mass, higher BMI,^{8, 12, 14} and decreased academic achievement.^{8, 20} Other types of sedentary behavior, particularly using new media devices (e.g., cell phones, laptops, tablets) appear to be on the rise among children and teens⁷ but have not been related to risk for obesity.

Strategies for reducing the amount of time young people spend in sedentary behaviors include targeted interventions and policies that support walking, biking, and active play in schools and communities.

- Schools are the most common setting for delivering educational messages and curricula intended to reduce time children spend watching TV at home.^{13, 82, 83} Such interventions have proven effective at reducing TV time among children, but these interventions typically do not specify which physical activities should replace sedentary time.⁸²
- Electronic TV monitoring devices are the most effective way to limit children's TV time.⁸⁴ Little is known about interventions that effectively reduce sedentary time occurring outside of the home (i.e., in preschool, in school, or during car travel).¹⁴
- Pilot research has shown adjustable sit/stand desks that allow children to stand during school time are a promising way to reduce sedentary time among elementary school children.^{82, 83}
- Neighborhoods, parks, and schools can help children and their families be more active and reduce sedentary time by providing safe, appealing, and convenient places to walk, bike, and play. For example, children are more physically active when they live in neighborhoods perceived as being free of crime,⁸⁵ and that have sidewalks and destinations, such as parks,⁸⁶ schools, and shops, within walking distance.⁸⁷ Being able to walk or bike to school can help counteract sedentary time spent riding in a car and contribute up to 26 percent of a child's daily recommended physical activity.⁸⁸ Parks in particular encourage physical activity, especially when they are safe,⁸⁸ and contain trails and playgrounds.⁸⁷ Access to programs and facilities, including ball fields and schoolyards, after school hours,^{90, 91} can also help kids be more physically active.

FUTURE RESEARCH NEEDS

- There is a need to develop improved definitions, measures and cut-off points for determining levels of excessive sedentary time.
- More evidence is needed on the health impacts of TV viewing and overall sedentary time on children and youth. This evidence could inform the development of new recommendations with clearer guidelines for what constitutes acceptable versus excessive sedentary behavior.
- Research needs to clarify how much of TV's negative health impacts are due to TV's impact on eating, sedentary behavior, or both.
- Future studies need to assess TV viewing using objective measures. New measurement technologies should be able to achieve this goal.
- Most studies of sedentary behavior rely on self-reports (i.e., surveys). More research is needed to evaluate the validity and reliability of self-report instruments.
- The most commonly studied sedentary behaviors among youth are TV viewing, video games, and other recreational screen-based activities. Additional research should also examine other sedentary behaviors, including sitting time during school, socializing with friends, and riding in a car. Future studies can use a combination of movement and physiological sensors to provide an overall estimate of time spent in sedentary behaviors.
- More research is needed to evaluate the effectiveness of interventions designed to reduce sedentary behavior, particularly among racial and ethnic minority children and other youth at greatest risk of being sedentary.
- The presence of TVs in children's bedrooms is related to overweight and obesity. More knowledge is needed on why families have TVs in children's rooms in order to develop interventions to change this practice.

Prepared by Deborah W. Lou, PhD, Active Living Research

Peer review provided by Susan B. Sisson, PhD, CHES, HFS, University of Oklahoma and Marc A. Adams, PhD, MPH, Arizona State University

Suggested Citation Lou, D. Sedentary Behaviors and Youth: Current Trends and the Impact on Health. San Diego, CA: Active Living Research; 2014. Available at www.activelivingresearch.org.

REFERENCES

- 1 Troiano RP, Berrigan D, et al. Physical activity in the United States measured by accelerometer. *Medicine & Science In Sports & Exercise* 2008; 40(1):181–188.
- 2 Hamilton MT, Hamilton DG, Zderic TW. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes*. 2007; 56:2655–2667.
- 3 Bergouignan A, Rudwill F, Simon C, Blanc S. Physical inactivity as the culprit of metabolic inflexibility: Evidence from bed-rest studies. *J Appl Phys*. 2011; 111(4):1201–10. doi: 10.1152/jappphysiol.00698.2011. Epub 2011 Aug 11.
- 4 Stephens BR, Granados K, Zderic TW, Hamilton MT, Braun B. Effects of 1 day of inactivity on insulin action in healthy men and women: interaction with energy intake. *Metabolism*. Jul 2011; 60(7):941–949.
- 5 Dunstan DW, Barr EL, Healy GN, et al. Television viewing time and mortality: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Circulation*. 2010; 121(3):384–91. Epub 2010/01/13.
- 6 Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Med Sci Sports Exerc*. 2009; 41(5):998–1005. Epub 2009/04/07.
- 7 Rideout VJ, Foehr UG, Roberts DF. Generation M2: media in the lives of 8- to 18-year-olds. A Kaiser Family Foundation Study. January 2010.
- 8 Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act*. 2011 Sep 21; 8:98. doi: 10.1186/1479-5868-8-98.
- 9 Ekelund U, Brage S, Froberg K, et al. TV viewing and physical activity are independently associated with metabolic risk in children: the European Youth Heart Study. *PLoS medicine*. 2006; 3(12):e488.
- 10 Mark AE, Janssen I. Relationship between screen time and metabolic syndrome in adolescents. *J Public Health (Oxford, England)*. 2008; 30(2):153–60.
- 11 Pearson N, Biddle SJ. Sedentary behavior and dietary intake in children, adolescents, and adults: a systematic review. *Am J Prev Med*. 2011; 41(2):178–188.
- 12 te Velde SJ, van Nassau F, Uijtdewilligen L, van Stralen MM, Cardon G, De Craemer M. Energy balance-related behaviours associated with overweight and obesity in preschool children: a systematic review of prospective studies. *Obes Reviews*. 2012; 13(S1): S56–S74.
- 13 The Obesity Prevention Source. Harvard School of Public Health Website. Available at: www.hsph.harvard.edu/obesity-prevention-source/obesity-causes/television-and-sedentary-behavior-and-obesity/#TV-Viewing-and-Childhood-Obesity. Accessed online August 22, 2013.
- 14 Salmon J, Tremblay JS, Marshall SJ, Hume C. Health risks, correlates, and interventions to reduce sedentary behavior in young people. *Am J Prev Med*. 2011; 41(2):197–206.
- 15 Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. *J Am Med Assoc*. 2012; 307(5):483–490.
- 16 Freedman DS, Zuguo M, Srinivasan SR, Berenson GS, Dietz WH. Cardiovascular risk factors and excess adiposity among overweight children and adolescents: the Bogalusa heart study. *J Pediatr*. 2007; 150(1):12–17.e2.
- 17 Li C, Ford ES, Zhao G, Mokdad AH. Prevalence of pre-diabetes and its association with clustering of cardiometabolic risk factors and hyperinsulinemia among US adolescents: NHANES 2005–2006. *Diabetes Care* 2009; 32:342–347.
- 18 The Surgeon General's Vision for a Healthy and Fit Nation. Rockville (MD): Office of the Surgeon General (US) 2010. www.ncbi.nlm.nih.gov/books/NBK44660/. Accessed November 21, 2012.
- 19 Dietz WH. Overweight in childhood and adolescence. *New England J Med*. 2004; 350:855–857.
- 20 Hancox RJ, Milne BJ, Poulton R. Association between child and adolescent TV viewing and adult health: a longitudinal birth cohort study. *Lancet*. 2004; 364:257–262.
- 21 Lopes L, Santos R, Pereira B, Lopes VP. Associations between sedentary behavior and motor coordination in children. *Am J Hum Biol*. 2012; 24: 746–752. doi: 10.1002/ajhb.22310.
- 22 Gopinath B, Hardy LL, Baur LA, Burlutsky G, Mitchell P. Physical activity and sedentary behaviors and health-related quality of life in adolescents. *Pediatrics* 2012; 130; e167–e174. Available at: <http://pediatrics.aapublications.org/content/130/1/e167.full.html>. Accessed November 21, 2012.
- 23 Buchowski MS, Sun M. Energy expenditure, television viewing, and obesity. *Int J Obes Rel Metab*. 1996; 20:236–244.
- 24 Epstein LH, Roemmich JN. Reducing sedentary behavior: role in modifying physical activity. *Exerc Sport Sci Rev*. 2001; 29(3):103–108.
- 25 Sedentary Behaviour Research Network. Standardized use of the terms "sedentary" and "sedentary behaviours". *Appl Physiol Nutr Metab*. 2012; 37: 540–542.
- 26 Sternfeld B and Goldman-Rosas L. A systematic approach to selecting an appropriate measure of self-reported physical activity or sedentary behavior. *J Phys Act Health*. 2012 Jan; 9 Suppl 1.
- 27 Pettee Gabriel KK, Morrow JR, Woolsey A-LT. Framework for physical activity as a complex and multidimensional behavior. *J Phys Act Health*. 2012 Jan; 9 Suppl 1:S11–8.
- 28 Troiano RP, Pettee Gabriel KK, Welk GJ, Owen N, and Sternfeld B. Reported physical activity and sedentary behavior: Why do you ask? *J Phys Act Health*. 2012 Jan; 9 Suppl 1.
- 29 Pate R, O'Neill J, Lobelo F. The evolving definition of "sedentary." *Exerc Sport Sci Rev*. 2008.
- 30 American Academy of Pediatrics. Committee on Public Education. Children, Adolescents, and Television. *Pediatrics*. 2001; 107(2):423–426.
- 31 Active Start: A Statement of Physical Activity Guidelines for Children From Birth to Age 5, 2nd Edition. Available at: www.aahperd.org/naspe/standards/nationalguidelines/activestart.cfm. Accessed July 23, 2013.
- 32 Tremblay MS, Leblanc AG, Carson V, et al. Canadian sedentary behaviour guidelines for the early years (aged 0–4 years). *Appl Physiol Nutr Metab*. 2012; 37(2):370–91.
- 33 Hamilton MT, Hamilton DG, Zderic TW. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes*. 2007; 56:2655–2667.
- 34 Bowles HR. Measurement of active and sedentary behaviors: closing the gaps in self-report methods. *J Phys Act Health*. 2012 Jan; 9 Suppl 1.

- 35 Barr-Anderson DJ, Sisson SB. Media use and sedentary behavior in adolescents: what do we know, what has been done and where do we go? *Adolesc Med*. 2012; 023(2012):511-28.
- 36 Sedentary Behaviour and Obesity Expert Working Group. Sedentary Behaviour and Obesity: Review of the Current Scientific Evidence. 2010. Department of Health's Cross Government Obesity Unit (United Kingdom).
- 37 Hinkley T, Salmon J, Okely AD, Trost SG. Correlates of sedentary behaviours in preschool children: a review. *Int J Behav Nutr Phys Act*. 2010; 7:66. Available at: www.ijbnpa.org/content/7/1/66. Accessed February 9, 2013.
- 38 De Craemer M, De Decker E, De Bourdeaudhuij I, Vereecken C, Deforche B, Manios Y. Correlates of energy balance-related behaviours in preschool children: a systematic review. *Obes Rev*. 2012; 13(S1), 13–28.
- 39 Ekelund U, Luan J, Sherar LB, Esliger DW, Griew P, Cooper A. Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. *JAMA*. 2012; 307(7):704-712.
- 40 Physical Activity Guidelines for Americans. 2008. US Department of Health and Human Services. Available at: www.health.gov/paguidelines/guidelines/. Accessed October 7, 2013.
- 41 Singh GK, Kogan MD, Van Dyck PC, Siahpush M. Racial/ethnic, socioeconomic, and behavioral determinants of childhood and adolescent obesity in the United States: analyzing independent and joint associations. *Annals of Epidem*. 2008; 18(9): 682-695.
- 42 Jackson DM, Djafarian K, Stewart J, et al. Increased television viewing is associated with elevated body fatness but not with lower total energy expenditure in children. *Am J Clin Nutr*. 2009; 89:1031–6.
- 43 Rey-López J, Ruiz JR, Vicente-Rodríguez G, et al. Physical activity does not attenuate the obesity risk of TV viewing in youth. *Pediatr Obes*. 2012; 7:240–50.
- 44 Carson V, Janssen I. Volume, patterns, and types of sedentary behavior and cardio-metabolic health in children and adolescents: a cross-sectional study. *BMC Public Health*. 2011; 11:274.
- 45 Dodor BA, Shelley MC, Hausafu CO. Adolescents' health behaviors and obesity: Does race affect this epidemic? *Nutr Res Pract*. 2010; 4(6): 528-524. doi: 10.4162/nrp.2010.4.6.528.
- 46 Viner RM, Cole TJ. Television viewing in early childhood predicts adult body mass index. *J Pediatr*. 2005; 147(4):429-35.
- 47 Boone JE, Gordon-Larsen P, Adair LS, Popkin BM. Screen time and physical activity during adolescence: longitudinal effects on obesity in young adulthood. *Int J Beh Nutr Phys Act*. 2007; 4:26. Available at: www.ijbnpa.org/content/4/1/26. Accessed on February 2, 2013.
- 48 Sisson SB, Broyles ST, Baker BL, Katzmarzyk PT. Screen time, physical activity, and overweight in U.S. youth: national survey of children's health 2003. *J Adolesc Health*. 2010 Sep; 47(3):309-11. doi: 10.1016/j.jadohealth.2010.02.016. Epub 2010 Apr 28.
- 49 Sisson SB, Shay CM, Broyles ST, Leyva M. Television-viewing time and dietary quality among US children and adults. *Am J Prev Med* 2012; 43(2):196-200. Epub 2012/07/21.
- 50 Lipsky LM, Iannotti RJ. Associations of television viewing with eating behaviors in the 2009 health behaviour in school-aged children study. *Arch Pediatr Adolesc Med*. 2012; 166(5):465-72. doi: 10.1001/archpediatrics.2011.1407.
- 51 Pearson N, Ball K, Crawford D. Mediators of longitudinal associations between TV viewing and eating behaviours in adolescents. *Int J Behav Nutr Phys Act*. 2011; 8(23). doi:10.1186/1479-5868-8-23.
- 52 Matheson DM, Killen JD, Wang Y, Varady A, Robinson TN. Children's food consumption during television viewing. *Am J Clin Nutr*. 2004; 79: 1088–94.
- 53 Barr-Anderson DJ, Larson NI, Nelson MC, Neumark-Sztainer D, Story M. Does television viewing predict dietary intake five years later in high school students and young adults? *Int J Behav Nutr Phys Act*. 2009; 6(7). Available at: www.ijbnpa.org/content/6/1/7. Accessed on February 25, 2013.
- 54 Zimmerman FJ, Bell JF. Associations of TV content type and obesity in children. *Am J Public Health*. 2010; 100:334–40.
- 55 Matthews CE, Chen KY, Freedson PS, Buchowski MS, Beech BM, Pate RR. Amount of time spent in sedentary behaviors in the United States, 2003-2004. *Am J of Epidemiol*. 2008; 167:875-881.
- 56 Vandewater EA, Rideout VJ, Wartella EA, Huang X, Lee JH, Shim MS. Digital childhood: electronic media and technology use among infants, toddlers, and preschoolers. *Pediatrics*. 2007; 119: e1006-e1015. Available at: <http://pediatrics.aappublications.org/content/119/5/e1006.full.html>. Accessed November 21, 2012.
- 57 Sisson SB, Church TS, Martin CK, et al. Profiles of sedentary behavior in children and adolescents: the US National Health and Nutrition Examination Survey, 2001-2006. *Int J Pediatr Obes*. 2009; 4:353–9.
- 58 Eaton DK, Kann L, Kinchen S, Shanklin S, Flint KH, Hawkins J. Youth risk behavior surveillance—United States, 2011. *MMWR Surveill Summ*. 2012 Jun 8; 61(4):1–162.
- 59 Hofferth SL. Changes in American children's time — 1997 to 2003. *Electron Int J Time Use Res*. 2009 6(1): 26–4. Available at: www.ncbi.nlm.nih.gov/pmc/articles/PMC2939468/pdf/nihms175487.pdf. Accessed March 20, 2013.
- 60 Sisson SB, Broyles ST, Brittain D, Short K. Obesogenic behaviors in U.S. children across geographic regions from 2003-2007. *Open J Prev Med*. 2011; 1(2):25-33. Available at: www.scirp.org/journal/OJPM/. Accessed March 10, 2013.
- 61 How children get to school: school travel patterns from 1969 to 2009. National Center for Safe Routes to School 2011 report. Available at: www.saferoutesinfo.org/program-tools/NHTS-school-travel-1969-2009. Accessed on October 7, 2013.
- 62 UK Office for National Statistics. Social trends no. 40. London: Palgrave Macmillan, 2010:280.
- 63 van der Ploeg HP, Merom D, Corpuz G, Bauman AE. Trends in Australian children traveling to school 1971–2003: burning petrol or carbohydrates? *Prev Med*. 2008; 46:60–2.
- 64 Centers for Disease Control. Obesity Prevalence among Low-Income, Preschool-Aged Children—United States, 1998-2008. *MMWR Morb Mortal Wkly Rep*. 2009; 58(28):769–73.
- 65 Gordon-Larsen P, Nelson MC, Popkin BM. Longitudinal physical activity and sedentary behavior trends: Adolescence to adulthood. *Am J Prev Med*. 2004; 27(4):277–83.
- 66 Zero to Eight: Children's media use in America. Fall 2011. Common Sense Media. Available at: www.commonsensemedia.org/research/zero-eight-childrens-media-use-america. Accessed February 30, 2013.

- 67 Pate RR, Mitchell JA, Byun W, Dowda M. Sedentary behavior in youth. *Br J Sports Med*. 2011; 45:906-913. doi: 10.1136/bjsports-2011-090192.
- 68 Whitt-Glover MC, Taylor WC, Floyd MF, Yore MM, Yancey AK, Matthews CE. Disparities in physical activity and sedentary behaviors among US children and adolescents: prevalence, correlates, and intervention implications. *J Pub Health Policy*. 2009; 30: S309–S334.
- 69 McDonald N, Brown AL, Marchetti LM, Pedroso MS. US school travel, 2009: An assessment of trends. *Am J Prev Med*. 2011; 41(2):146–151. Available at: http://planning.unc.edu/people/faculty/noreenmcdonald/McDonald_etal_SchoolTravel2009NHTS_AJPM2011.pdf. Accessed February 20, 2013.
- 70 Fakhouri THI, Hughes JP, Brody DJ, Kit BK, Ogden CL. Physical activity and screen-time viewing among elementary school-aged children in the United States from 2009 to 2010. *Pediatrics*. 2013; 167(3): 223-229.
- 71 Liu J, Jones SJ, Sun H, Probst JC, Cavicchia P. Diet, physical activity, and sedentary behaviors as risk factors for childhood obesity: an urban and rural comparison. *Child Obes*. 2012 Oct; 8(5):440-8. Available at: <http://hr.sph.sc.edu/report/percent2891percent29Diet,percent20Physicalpercent20Activitypercent20andpercent20Sedentarypercent20Behaviors.pdf>. Accessed Nov. 28, 2012.
- 72 Nelson MC, Neumark-Stzainer D, Hannan PJ, Sirard JR, Story M. Longitudinal and secular trends in physical activity and sedentary behavior during adolescence. *Pediatrics*. 2006; 118; e1627. doi: 10.1542/peds.2006-0926.
- 73 Brodersen NH, Steptoe A, Boniface DR, Wardle J. Trends in physical activity and sedentary behaviour in adolescence: ethnic and socioeconomic differences. *Br J Sports Med*. 2007; 41(3):140-4.
- 74 Verloigne M, Van Lippevelde W, Maes L, Yildirim M, Chinapaw M, Manios Y. Levels of physical activity and sedentary time among 10- to 12-year-old boys and girls across 5 European countries using accelerometers: an observational study within the ENERGY-project. *Int J Behav Nutr Phys Act*. 2012; 9:34. doi: 10.1186/1479-5868-9-34.
- 75 Dolinsky DH, Brouwer RJ, Evenson KR, Siega-Riz AM, Østbye T. Correlates of sedentary time and physical activity among preschool-aged children. *Prev Chronic Dis*. 2011; 8(6):A131. Available at: www.cdc.gov/pcd/issues/2011/nov/11_0006.htm. Accessed September 21, 2012.
- 76 Marshall SJ, Gorely T, Biddle SJH. A descriptive epidemiology of screen-based media use in youth: a review and critique. *J Adolesc*. 2006; 29:333-349.
- 77 Lajous M, Chavarro J, Peterson K. et al. Screen time and adiposity in adolescents in Mexico. *Pub Health Nutr*. 2009; 12(10):1938–1945.
- 78 Barr-Anderson DJ, van den Berg P, Neumark-Sztainer D, Story M. Characteristics associated with older adolescents who have a television in their bedrooms. *Pediatrics*. 2008; 121(4):718–24.
- 79 Sisson SB, Broyles ST, Newton RL, Jr., Baker BL, Chernausk SD. TVs in the bedrooms of children: does it impact health and behavior? *Prev Med*. 2011; 52(2):104-8. Epub 2010/12/07.
- 80 Taveras EM, Hohman KH, Gortmaker SL, Sonneville K. Televisions in the bedrooms of racial/ethnic minority children: How did they get there and how do we get them out? *Clin Pediatr*. 2009; 48:715. Available at: <http://cpj.sagepub.com/content/48/7/715>. Accessed August 19, 2013.
- 81 Adachi-Mejia AM, Longacre MR, Gibson JJ, Beach ML, Titus-Ernstoff LT, Dalton MA. Children with a TV in their bedroom at higher risk for being overweight. *Int J Obes (Lond)*. 2007; 31(4):644-51. Epub 2006/09/14.
- 82 Kamath CC, Vickers KS, Ehrlich A, et al. Behavioral interventions prevent childhood obesity: A systematic review and metaanalyses of randomized trials. *J Clin Endocrinol Metab*. 2008; 93:4606–15.
- 83 DeMattia L, Lemont L, Meurer L. Do interventions to limit sedentary behaviors change behavior and reduce childhood obesity? A critical review of the literature. *Obes Rev*. 2006; 8:69–81.
- 84 Steeves JA, Thompson DL, Bassett DR, Fitzhugh EC, Raynor HA. A review of different behavior modification strategies designed to reduce sedentary screen behaviors in children. *J Obes*. 2012 Article ID 379215, 16 pages, 2012. doi: 10.1155/2012/379215.
- 85 Molnar BE, Gortmaker SL, Bull FC. Unsafe to play? neighborhood disorder and lack of safety predict reduced physical activity among urban children and adolescents. *Am J Health Prom*. 2004; 18:378–386.
- 86 Epstein LH, Raja S, Gold SS, Paluch RA, Pak Y, Roemmich JN. Reducing sedentary behavior: the relationship between park area and the physical activity of youth. *Psychological Science*. 2006; 17(8):654–659.
- 87 Davison KK, Lawson CT. Do attributes in the physical environment influence children's physical activity? A review of the literature. *Int J Beh Nutr Phys Act*. 2006; 319.
- 88 Bassett DR, Fitzhugh EC, Heath GW, Erwin PC, Frederick GM, Wolff DL, Welch WA, Stout AB. Estimated energy expenditures for school-based policies and active living. *Am J Prev Med*. 2013; 44(2):108–13. doi: 10.1016/j.amepre.2012.10.017.
- 89 Babey SH, Haster TA, Yu H, Brown R. Physical activity among adolescents: when do parks matter? *Am J Prev Med*. 2008; 34(4):345–348.
- 90 Durant N, Harris SK, Doyle S, Person S, Saelens BE, Kerr J, Norman GJ, Sallis JF. Relation of school environment and policy to adolescent physical activity. *J Sch Health*. 2009; 79(4):153–159.
- 91 Farley TA, Meriwether, RA, Baker ET, Watkins LT, Johnson CC, Webber LS. Safe play spaces to promote physical activity in inner-city children: results from a pilot study of an environmental intervention. *Am J Pub Health*. 2007; 97(9):1625–1631.