Published in final edited form as:
Comput Human Behav. 2014 June ; 35: 364–375. doi:10.1016/j.chb.2014.01.036.

Media and technology use predicts ill-being among children, preteens and teenagers independent of the negative health impacts of exercise and eating habits

L.D. Rosen[*], **A.F. Lim**, **J. Felt**, **L.M. Carrier**, **N.A. Cheever**, **J.M. Lara-Ruiz**, **J.S. Mendoza**, and **J. Rokkum**

California State University, Dominguez Hills, United States

L.D. Rosen: lrosen@csudh.edu

Abstract

The American Academy of Pediatrics recommends no screen time for children under the age of 2 and limited screen time for all children. However, no such guidelines have been proposed for preteens and teenagers. Further, research shows that children, preteens, and teenagers are using massive amounts of media and those with more screen time have been shown to have increased obesity, reduced physical activity, and decreased health. This study examined the impact of technology on four areas of ill-being–psychological issues, behavior problems, attention problems and physical health–among children (aged 4–8), preteens (9–12), and teenagers (13–18) by having 1030 parents complete an online, anonymous survey about their own and their child's behaviors. Measures included daily technology use, daily food consumption, daily exercise, and health. Hypothesis 1, which posited that unhealthy eating would predict impaired ill-being, was partially supported, particularly for children and preteens. Hypothesis 2, which posited that reduced physical activity would predict diminished health levels, was partially supported for preteens and supported for teenagers. Hypothesis 3, that increased daily technology use would predict ill-being after factoring out eating habits and physical activity, was supported. For children and preteens, total media consumption predicted illbeing while for preteens specific technology uses, including video gaming and electronic communication, predicted ill-being. For teenagers, nearly every type of technological activity predicted poor health. Practical implications were discussed in terms of setting limits and boundaries on technology use and encouraging healthy eating and physical activity at home and at school.

Keywords

Media; Technology; Ill-being; Health; Video gaming; Screen time; Children; Preteens; Teenagers; Physical activity; Exercise; Electronic communication; Television; Obesity; Attention; Food consumption

[*]Corresponding author. Address: Department of Psychology, California State University, Dominguez Hills, Carson, CA 90747, United States. Tel.: +1 310 243 3427; fax: +1 619 342 1699.

1. Introduction

The American Academy of Pediatrics recommends no more than 2 h per day of screen time for preschool children and no screen time for children under the age of 2 with screen time defined as time spent using or watching televisions, computers, phones and other electronic devices (Committee on Public Education, 2001). However, a study at the University of Washington of 8950 children under the age of 5 found that 66% exceeded that limit, spending an average of 4.1 h of daily screen time, 90% of which came at home (Tandon, Zhou, Lozano, & Christakis, 2011). By the time children reach adolescence, screen time soars to 7.5 h per day with more than one-fourth spent media multitasking for a total daily screen time of 10 h and 45 min (Rideout, Foehr, & Roberts, 2010).

Research has also shown that twice as many children and three times as many adolescents are suffering from obesity than just 30 years ago based on increased body mass index scores (National Center for Health Statistics, 2012; Ogden, Carroll, Kit, & Flegal, 2012). In particular, during that same 30-year period, the Center for Disease Control and Prevention (CDC) reported that the percentage of obese 6- to 11-year-olds increased from 7% to 18% while the percentage of obese 12- to 19-year-olds increased similarly from 5% to 18% (CDC, 2013a).

Further, screen time has been linked to increased obesity among children (Anderson & Whitaker, 2010; de Jong et al., 2013; Fitzpatrick, Pagani, & Barnett, 2012; Pagani, Fitzpatrick, Barnett, & Dubow, 2010) and adolescents (Arora et al., 2012; Barnett et al., 2010; Bickham, Walls, Shrier, Blood, & Rich, 2012; Casiano, Kinley, Katz, Chartier, & Sareen, 2012; Do, Shin, Bautista, & Foo, 2013) as well as a reduction in exercise which research shows is predicted by increased media consumption (Anderson, Economos, & Must, 2008; Boone, Gordon-Larsen, Adair, & Popkin, 2007; Cox et al., 2012; Martin, 2011; Sisson, Broyles, Baker, & Katzmarzyk, 2010; Tandon, Zhou, Sallis, Cain, Frank, & Saelens, 2012). However, it is not simply about time displacement, as a review of studies found that reduced screen time does not necessarily promote increased exercise (Martin, 2011).

Research has also shown that excessive screen use including television, video games, and the Internet predicted a variety of psychological and medical health issues (Martin, 2011). The current study was designed to expand on current work and examine the impact of the use of *specific technologies* among children, preteens, and teenagers on four areas of ill-being: physical problem symptomology, psychological symptom manifestation, attention problems, and home and classroom behaviors. Further, this study will first test the predicted relationships between eating habits and ill-being as well as that between exercise and ill-being, both of which have been documented in the literature. Finally, a path model will be tested that asks the question: “Is there a relationship between media use and ill-being after accounting for the known relationships between exercise and ill-being and eating habits and ill-being as well as demographic characteristics of children, preteens and teenagers and their parents?”

1.1. The impact of screen time on health

While most studies have examined specific media and technology activities, such as television, video gaming, and Internet use, several studies have investigated the impact of total screen time on the health of both children and adolescents. One study of Scottish youth found that total screen time predicted psychological distress independent of physical activity levels (Hamer, Stamatakis, & Mishra, 2009) while another study of Australian adolescents (Martin, 2011) found that excessive screen time predicted increased loneliness, depression, withdrawal, anxiety, attention problems, and aggression. Finally, a third study conducted by Messias, Castro, Saini, Usman, and Peeples (2011) found that excessive amounts of screen time, particularly Internet activity and video gaming, predicted more sadness, suicidal ideation and suicide planning among American teens. In addition, a study of Norwegian teens demonstrated that a combination of more television, video and computer use lead to more back pain and headaches (Torsheim et al., 2010). A recent review paper summarized the impact of screen time by showing that it predicted increased aggression, aggressive feelings, and social isolation among children and adolescents (Ray & Jat, 2010).

1.2. The impact of television on health

Several studies have examined the impact of television viewing at a young age on later health. For example, research has found that: (1) more television viewing at 29 months and 53 months of age predicted more victimization problems and more attention problems at 10 years of age (Parkes, Sweeting, Wight, & Henderson, 2013; Pagani et al., 2010); (2) more TV viewing at 30–33 months predicted more behavior problems at 5 years of age (Mistry, Minkovitz, Srobino, & Borzekowski, 2007), (3) more television viewing at age 5 predicted more psychosocial adjustment problems at age 7 (Parkes et al., 2013), (4) more television at ages 1 and 3 predicted more attention problems at age 7 (Cristakis, Zimmerman, DiGiuseppe, & McCarty, 2004), and (5) more television in middle school predicted more attention problems in late adolescence (Swing, Gentile, Anderson, & Walsh, 2010).

Some studies have qualified these results showing that perhaps the television content–particularly nonviolent and violent entertainment shows compared with educational shows–may be the culprit instead of total television time (Zimmerman & Cristakis, 2007), while other studies (Hamer et al., 2009; Page, Cooper, Griew, & Jago, 2010) showed that it is not the case that television supplants activity leading to poorer health, but rather the two show independent effects. A longitudinal study that tracked New Zealand youth between the ages of 5 and 15 found similar results showing increased television exposure in childhood leading to increased attention problems in the teenage years (Landhuis, Poulton, Welch, & Hancox, 2007). Finally, another study examined the specific impact of television viewing on sleep quality and found that more television viewing in the last 90 min before sleep resulted in worse sleep quality in children (Foley et al., 2013).

Finally, some studies have shown that it is the content of the television programming that best predicts problem behaviors including increased aggression (Strasburger, Jordan, & Donnerstein, 2010), while another study found that the negative impacts of violent media content predicted antisocial behavior, inattention, and emotional distress among Canadian school children in second grade (Fitzpatrick et al., 2012).

1.3. The impact of video gaming and Internet use on health

A wealth of studies has shown consistent results of the effects of video gaming on health. For example, Romer, Bagdasarov, and More (2013) showed that heavy video game usage, regardless of the content, predicted depression among adolescents and young adults, which was corroborated by Lemmens, Valkenburg, and Peter (2011) with Dutch adolescents and by Gentile et al. (2011) with American youth. Other studies have highlighted more negative impacts of video gaming on youth including delinquency and both externalizing and internalizing problems (Holtz & Appel, 2011) among 10- to 14-year-olds; attention problems among adolescents in Singapore (Gentile, Swing, Lim, & Khoo, 2012); increased social phobia, anxiety and lower academic performance among American children and preteens (Gentile et al., 2011); and depression, social withdrawal and anxiety among adolescents and young adults who played “massively multiplayer online role-playing games” (MMORPGs; Scott & Porter-Armstrong, 2013). One study did show that video gaming behavior at age 5 did not predict psychosocial adjustment issues at age 7 (Parkes et al., 2013).

On the other hand, much of the research on the negative impacts of video gaming has focused on the violent aspects of the games themselves. For example, Brown and Bobkowski (2011) found that those adolescents who played more violent video games demonstrated more aggression, which was corroborated by other researchers with Dutch adolescents (Lemmens et al., 2011). However, Gunter and Daly (2012) found that this relationship was not mediated by the propensity for violence among eighth grade American students. In addition, studies of college students have shown that the effects of playing violent games for even a short period of time encouraged them to give a punishing loud noise blast after outscoring another player (Hasan, Bègue, Scharkow, & Bushman, 2013) and that this effect persisted 24 h after completing a short session of violent video gaming (Bushman & Gibson, 2011).

Additional research has shown that the impact of video gaming depends on with whom you are playing, showing that if you are playing with new people the result is increased loneliness while if you are playing with family and/or friends the impact can be an enhanced sense of positive well-being (Cuihua & Williams, 2011). One final result indicated that more video gaming in the last hour before sleep predicted a worse quality of sleep (Foley et al., 2013).

Some studies have looked at general Internet use, without examining specific sites or activities, and found a negative impact on depression among Swiss adolescents (Belanger, Akre, Berchtold, & Michaud, 2011), among American adolescents and young adults (Romer et al., 2013), and among Korean adolescents (Do et al., 2013; Park, Hong, Park, Ha, & Yoo, 2012). In addition, Foley et al. (2013) found that more Internet use in the last 90 min before sleep predicted a worse night's sleep among American children while other research suggested that more computer use among 10- and 11-year-old children predicted more psychological difficulties even after adjusting for activity levels (Page et al., 2010). Finally, studies with college students have shown that more Internet use was related to more depression (Cristakis, Moreno, Jelenchick, Myaing, & Zhou, 2011; Rosen, Whaling, Rab, Carrier, & Cheever, 2013) and one study by Kotikalapudi, Chellappan, Montgomery,

Wunsch, and Lutzen (2012) even demonstrated that specific types of online activity–assessed from computer records alone–could predict depression levels in American college students.

Previous research has also examined extreme use of the Internet, termed Internet addiction (Young, 1998), and found that while rates ranged from 1.6% to 36.7% of both American and non-American populations, those who were deemed to be addicted were found to show increased signs of depression, attention deficit disorder (both with and without the hyperactivity component), impulsivity, obsessive–compulsive disorder, hostility, and social anxiety (Carli et al., 2013; Gundogar, Bakim, Ozer, & Karamustafalioglu, 2012; Ko, Yen, Yen, Chen, & Chen, 2012).

1.4. Impact of media and technology use, physical activity, and eating habits on obesity

International statistics have shown that, based on body mass index (BMI) tables, obesity among adults is at an epidemic rate with studies finding obesity rates as high as 38% with 78% being judged as overweight (Taylor, 2011). Other studies have provided similar ranges of 25% to 38% obesity rates and 59% to 63% overweight rates among American adults with a recent nationwide Gallup poll finding 26.2% of American adults to be obese in 2012 which was unchanged from the 26.1% obesity rate found in 2011 (Hamblin, 2013). In one study by the Organization for Economic Cooperation and Development, the United States showed the highest overweight and obesity rates of 33 countries (Hellmich, 2010).

Arguments have been proffered that screen time promotes obesity through two vehicles: poor eating habits and/or lack of exercise. Evidence does show that the amount of television watched at 29 months and 53 months predicted increased BMI at age 10 due to increased eating and inadequate physical activity (Pagani et al., 2010) and an Australian study found that preschoolers who watched more television did have increased BMIs but they were mediated by both lack of physical activities and consuming more food calories while watching television (Cox et al., 2012). A study of 10- to 12-year-olds in seven European countries found that those who had a television in their bedroom, and particularly those who watched more daily television, had increased BMI levels (Cameron et al., 2012). More television, video games, and computer use among American teens predicted increased body fat (Barnett et al., 2010) while similar results were found for Canadian adolescents (Casiano et al., 2012), and Korean adolescents (Do et al., 2013). Other studies have refined these results showing that more primary attention to television, but not overall television time, predicted higher BMIs in American adolescents (Bickham et al., 2012) while more television during early childhood predicted larger waist circumference among fourth grade Canadian students (Fitzpatrick et al., 2012) and more technology at bedtime, particularly television and video games, predicted higher BMIs in UK adolescents (Arora et al., 2012).

In terms of the impact of physical activity on health, a study of 4- to 11-year-old American children found that while 37% had low levels of active play and 65% had high levels of screen time, 26% had a combination of both (Anderson et al., 2008). Data from the 2009–2010 National Health Examination Survey, using a representative sample of American 6- to 11-year-olds, found that fewer than four in 10 children met both physical activity and screen time guidelines (Fakhouri, Hughes, Brody, Kit, & Ogden, 2013) while a study of Australian

preschool children aged 2–6 found that those who watched more daily television had significantly higher BMI levels, which were moderated by both lack of physical activity and eating food while watching television (Cox et al., 2012). A recent study of adolescents found that the amount of physical activity was predicted by a combination of television use and computer use (Babey, Hastert, & Wolstein, 2013) and a similar study of adolescents found that both screen time and physical activity predicted obesity in females while only physical activity did the same for males (Boone et al., 2007). A study of 3rd, 4th, and 5th grade Iowa school children found that normal weight children used less screen time compared to overweight and obese children who used significantly more screen time (Iowa Department of Public Education, 2008) and a national study of 6- to 17-year-olds found that those with low physical activity and high leisure time sedentary activity (television and video viewing and video game playing) were twice as likely to be overweight (Sisson et al., 2010).

1.5. Hypotheses

Hypothesis 1—Unhealthy eating will predict ill-being even after factoring out parent and child demographics, and daily technology use.

Given data showing the relationship between parent and child demographics and unhealthy eating, this hypothesis will be tested using hierarchical multiple regressions factoring out parent and child demographics, and media usage (total and each type of media/technology) to determine if unhealthy eating predicts ill-being.

Hypothesis 2—Lack of physical activity will predict ill-being even after factoring out parent and child demographics, and daily technology use.

Given data showing the relationship between parent and child demographics, and lack of physical activity, this hypothesis will be tested using hierarchical multiple regressions factoring out parent and child demographics, and media usage (total and each type of media/technology) to determine if lack of physical activity predicts ill-being.

Hypothesis 3—After factoring out both demographic data for parent and child, unhealthy eating, and lack of physical activity, media usage will predict ill-being.

Given the data showing the relationship between technology use and ill-being, this hypothesis will be tested using hierarchical multiple regression factoring out parent and child demographics, unhealthy eating and lack of physical activity to determine if media activity (total and each type of media/technology) predicts ill-being.

2. Methods

2.1. Participants

Participants (N = 1030) were recruited by students in an upper division general education course from the local Southern California area and given a web link to complete an anonymous, online survey. Each student recruited 10 parents as participants with the requirement that the parent's child be selected equally from three age groups (with the 10th from any age group): 4- to 8-year-olds (n = 338), 9- to 12-year-olds (n = 316), and 13- to 18-

year-olds (n = 376). Children were equally divided between males (51%) and females (49%). Parents were primarily female (70%) and averaged 39.24 years of age (SD = 8.64). Parents and children comprised the following ethnic groups: Asian/Asian-American/Pacific Islander (parent: 12%; child: 12%), Black/African-American (18%; 18%), Caucasian (24%; 22%), Hispanic/Latino/a/Spanish descent (41%; 39%), other (5%; 10%). These figures match the census figures for the Los Angeles area (U.S. Census Bureau, 2006). Nearly all parents (84%) were not currently enrolled in school and the majority (60%) was employed full time or part time (14%). Overall, 41% had a college degree and an additional 31% had some college; 69% were living with a partner or spouse, 7% were living with another adult and sharing parenting responsibilities, and 22% were single parents. Parents of teenagers were significantly older (M = 44.30; SD = 7.03) than parents of preteens (M = 39.49; SD = 7.68), who were significantly older than parents of children (M = 33.96; SD = 7.79); $F(2, 949) = 156.88$, $p < .001$. No other demographic characteristic differed between age groups except for whether the parent was currently enrolled in school (a higher percentage of parents with older children were enrolled in school; $\chi^2(df = 4) = 16.78$, $p < .01$) and a higher percentage of parents of younger children not employed or employed only part-time [$\chi^2(df = 8) = 20.43$, $p < .05$].

2.2. Instrumentation and materials

2.2.1. Demographic data—Parents were asked their gender, age, education level, and ethnic background (dummy coded) as well as the zip code of their residence, which was converted to a median income using the Census Bureau data (U.S. Census Bureau, 2000). The parents also indicated their child's age and gender.

2.2.2. Body mass index (BMI)—Parents were asked the approximate weight and height of both themselves and their child. These figures were converted to a BMI based on an online formula (CDC, 2013a,b,c).

2.2.3. Child physical problems—Parents were asked questions concerning their health as well as their child's health in four areas: Physical Health Symptomology (sick days in the last 12 months, general physical health, and two items—headaches and stomach aches—from an 11-item symptomology checklist developed by the experimenters.

2.2.4. Child behavior problems—The survey also asked about behavior problems in three items from the 11-item symptomology checklist: difficulty making and keeping friends, behaviors, and anger or emotional outbursts.

2.2.5. Child attention problems—The survey included the 18-item Attention Deficit Hyperactivity Disorder Rating Scale–IV–school version (DuPaul et al., 1997) with each item answered on a four-point scale of never or rarely, sometimes, often and very often. Additionally, a parent and child attention symptomology checklist (e.g., antisocial behaviors, difficulty paying attention) was included.

2.2.6. Child psychological problems—The survey included several items including two from the 11-item symptomology checklist (depression, anxiety), a single question that

queried the stress level on an average day (1 = not at all stressed to 10 = extremely stressed), the Yale Single Item Depression Scale which has been shown to be reliable and valid (Lachs et al., 1990) and the Rosenberg Self-Esteem Survey (Rosenberg, 1965).

2.2.7. Media and technology usage—Parents were asked a series of 10 questions concerning their daily media and technology usage (going online, using a computer for other than being online, sending and receiving e-mail, IMing/chatting, talking on the telephone, texting, playing video games, listening to music, and playing with technological toys) on a scale including: not at all, less than an hour, 1 h, 2 h, 3 h, 4–5 h, 6–8 h, 9– 10 h and more than 10 h per day (Carrier, Cheever, Rosen, Benitez, & Chang, 2009). In addition, parents were asked about their child's technology ownership (cell phone, iPod/MP3 player) and his/her use of technology in their bedroom (television, video games, computer, DVD player).

2.2.8. Child Outdoor Play and Exercise—Using the same scale as for media/ technology usage, parents were asked about their child's daily outdoor play or exercise in terms of hours per day. This single item was used to create a scale of physical activity.

2.2.9. Daily food consumption—Parents were asked about food consumption for themselves and their child including: dairy products, water, diet drinks, regular soda, energy drinks, coffee, fruits/vegetables, whole grains and beans, eggs, seafood, chicken/turkey, pork, beef, junk food and sweets, fried food, fast food meals, vitamins, alcohol, and cigarettes on a 10-point scale ranging from never through seven or more times a day. A subset of these items was used to construct a scale of unhealthy eating.

3. Results

3.1. Scale construction

After first converting all relevant items to z-scores, factor analyses—using a .50 minimum loading criterion—were used to develop scales which included the following ill-being factors for children: Physical Problems, Behavior Problems, Attention Problems, and Psychological Problems; a total Ill-Being score was computed from the mean z-scores of the four ill-being factors. Total Technology Use was created by summing the hours per day for all ten queried forms of media/technology and Unhealthy Eating was created by first converting consumption of diet soda, regular soda, energy drinks, coffee and coffee drinks, junk food and sweets, fried foods, and fast food meals to z-scores and then factor analyzing those z-scores into a single factor scale. Each scale was the mean z-score of all items loaded on that factor and all scales had Cronbach alpha reliability coefficients of .80 or above.

3.2. Food consumption

Fig. 1 displays food consumption data for parents and each child age group. As can be seen in this figure, children, preteens, teens, and parents are consuming junk food and sweets often as well as fried foods, fast food meals, and regular sodas. Although there may be overlap in how the parents answered the survey items, parents and children are consuming these four food groupings almost daily. In addition, older children are consuming regular

soda, energy drinks, and coffee drinks often with teens consuming more overall than preteens and children. Parents consumed the most coffee and diet drinks.

3.3. Child and parent BMI

Height and weight data were used to compute a BMI score which was then converted to a category according to CDC tables (CDC, 2013a,b,c). Overall, 52% of parents were overweight or obese with the children (66%), preteens (52%), and teens (38%) classified as overweight or at risk for obesity. These figures concur with the percentages shown in the work by the National Center for Health Statistics (National Center for Health Statistics, 2012).

3.4. Media/technology usage

For each of the 10 media/technology categories total hours and minutes were calculated using the following conversions: never = 0 h; less than 1 h per day = .5 h; 1, 2, and 3 h = their value; 4–5 h per day = 4.5; 6–8 h/day = 7; 9–10 = 9.5; and more than 10 = 11. Table 1 displays the hours and minutes for each media/technology with a total media usage calculated as the sum of the nine individual items. The total media usage is the sum of the hours for each form of media (Cronbach's alpha = .84) with all totals greater than three standard deviations above the mean truncated to exactly three standard deviations above the mean. It is important to note that each form of media/technology is likely not used separately due to multitasking (Carrier et al., 2009). However, these totals provide an assessment of the use of various media whether alone or along with other media. As can be seen in the table, children used 7 h of media/technology per day, compared with nearly 10 daily hours for preteens, and more than 18 daily hours for teens. In addition, F-tests demonstrated that with the exception of hours spent watching television, daily hours of all forms of media differed significantly between age groups. For all media/technology forms (including total usage) except video games and technological toys, teens spent significantly more hours than preteens, who spent significantly more hours than children using Tukey's b Test ($p < .05$). For video game playing, teens and preteens showed no significant difference but played significantly more than children. For technological toys, children spent significantly more hours per day than both preteens and teens, which did not differ significantly.

3.5. Hypothesis 1

The path model for the three hypotheses is depicted in Fig. 2. Hypothesis 1 predicted that after factoring out demographic data for both the parent and the child, in addition to factoring out the daily media usage, unhealthy eating would still predict ill-being beyond the predictability of demographics and technology use. This hypothesis was tested with a series of hierarchical multiple regressions where demographic data was first factored out followed by technology use before determining if unhealthy eating predicted ill-being. For each age group, 55 regression analyses were performed with independent variables including demographics plus each separate technology use plus total technology use (11 separate IVs in the second hierarchy) and five dependent variables including four specific forms of ill-being plus total ill-being. Analyses were executed this way to determine whether unhealthy

eating would predict ill-being regardless of the level of each form of technology usage. Examination of the potential statistical issues involved in performing a large number of regression analyses is discussed in the limitations section (see Fig. 2).

Table 2 presents the hierarchical regression beta weights for unhealthy eating predicting ill-being after factoring out demographic data for parent (age, gender, education, ethnicity, family median income, and parent BMI) and child (age, gender) for children, preteens, and teenagers including technology usage (with total technology plus the 10 individual technology types). For 4- to 8-year-olds the data in the top third of Table 2 indicates that when factoring out demographics and total daily technology use (as well as each individual technology use), unhealthy eating still predicted total ill-being, psychological issues, and attention problems. Unhealthy eating did not predict behavior problems after factoring out technology use and demographics, but unhealthy eating predicted behavior problems after factoring out most individual technologies although this was not true for total technology use, daily music or daily TV/DVD use. Hypothesis 1 was partially supported for children.

The middle portion of Table 2 displays the hierarchical regression beta weights for preteens (9- to 12-year-olds). Hypothesis 1 predicted that after factoring out demographic data for both the parent and the child, plus removing the effects of daily media usage, unhealthy eating would predict ill-being. This prediction was supported completely for total ill-being as well as psychological issues, attention problems and physical problems and mostly supported for behavior problems (with the exception of total technology use, daily e-mail use, daily IM/Chat use and daily phone use). Thus, Hypothesis 1 was supported for preteens.

The bottom portion of Table 2 shows the results of the Hypothesis 1 test for teenagers. In this case, unhealthy eating predicted attention problems (although not significantly when factoring out total daily technology use) while unhealthy eating predicted total ill-being only after factoring out three specific daily technology uses—being online, using a computer but not online, and using IM/Chat—but not total daily technology use or any of the other seven specific uses. Psychological issues, behavior problems and physical problems were not predicted by unhealthy eating after removing daily technology use and demographic data. Thus, Hypothesis 1 was only partially supported for teenagers.

3.6. Hypothesis 2

Hypothesis 2 predicted that lack of physical activity would predict ill-being even after factoring out child and parent demographics, and daily technology use. Table 3 presents the hierarchical regression beta weights for lack of physical activity predicting ill-being after factoring out demographic data for parent (age, gender, education, ethnicity, family median income, and parent BMI) and child (age, gender) for children, preteens, and teenagers plus technology usage (including total technology plus the 10 individual technology types). For 4- to 8-year-olds the data in the top third of Table 3 indicates that in fact lack of physical activity did not predict either total ill-being or any of the four individual forms of ill-being other than two instances, which are likely Type I errors. Hypothesis 2 was not supported with children. For preteens, the middle section of Table 3 shows that lack of physical activity predicted behavior problems both after factoring out demographics and total

technology use as well as each of the 10 types of technology use. Thus, Hypothesis 2 was only partially supported for preteens.

A different picture emerged for teenagers as seen in the bottom portion of Table 3. Lack of physical activity did predict total ill-being as well as two components of ill-being—psychological issues and behavior problems—after factoring out demographics and total daily technology use as well as all 10 types of daily technology use. In addition, the same results were found for physical problems but only after factoring out total technology use for five other individual daily technology uses: IM/Chat, phone, text, video games and music. Finally, lack of physical activity did not significantly predict attention problems for teenagers after factoring out demographics and daily technology use. Thus, Hypothesis 2 was partially supported for teenagers.

3.7. Hypothesis 3

Hypothesis 3 predicted that daily technology use would predict ill-being even after factoring out lack of physical activity, unhealthy eating, and child and parent demographics. Table 4 presents the hierarchical regression beta weights for technology use (including total technology plus the 10 individual technology types) predicting ill-being after factoring out demographic data for parent (age, gender, education, ethnicity, family median income, and parent BMI) and child (age, gender) plus physical activity and unhealthy eating separately for children, preteens, and teenagers. For 4- to 8-year-olds the data in the top third of Table 4 indicates daily technology use predicted total ill-being, attention problems and physical problems. For total ill-being and attention problems, daily music use and playing with technological toys were also significant predictors while for physical problems, daily use of music, TV/DVDs and technological toys were also significant predictors. No daily technology uses predicted psychological issues and only daily music predicted behavior problems. Thus, Hypothesis 3 was partially supported for children.

For preteens (9- to 12-year-olds), the middle portion of Table 4 shows that total daily technology use did significantly predict total ill-being and physical problems, but not psychological issues, behavior problems or attention problems. Taken one by one, total ill-being was significantly predicted by e-mail, IM/Chat, phone, video games and technological toys while physical problems were predicted by e-mail, IM/Chat, phone, testing, video games, and music). In contrast, psychological issues were only predicted by daily use of e-mail and phone, behavior problems were only predicted by daily use of technological toys and attention problems were only predicted by video game playing and technological toy use. Overall, Hypothesis 3 was partially supported for preteens.

For teenagers (13- to 18-year-olds), the data in the bottom portion of Table 4 paint a fairly clear picture. Total ill-being, and each of the four specific forms of ill-being, were predicted significantly by total technology use as well as nearly all individual forms of daily technology use. The one exception was behavior problems which were only predicted by total daily technology use and no individual uses. There is some variability in the impact of individual daily technology uses including lack of predictability of total ill-being by two uses (TV/DVD, technological toys), psychological issues by three daily uses (texting, TV/DVD, and technological toys), attention problems by three uses (computer, music and TV/

DVD) and physical problems by six uses (computer, e-mail, texting, video games, TV/DVD and technological toys). Overall, however, Hypothesis 3 was supported for teenagers.

4. Discussion

The current study was designed to test several hypotheses to better understand the causes of ill-being among children, preteens, and teenagers. A path model was proposed that tested two paths suggested from the literature including a path from unhealthy eating to ill-being after factoring out daily media and technology usage and a second path from lack of exercise to ill-being after factoring out daily media and technology usage. Finally, a third path model was tested that factored out both unhealthy eating and lack of physical activity to determine if media/technology use alone predicted ill-being. In each path model 10 distinct forms of media/technology use were tested individually as well as the total daily media consumption. In addition, each path model tested four different types of ill-being—psychological issues, behavior problems, attention problems, and physical problems—as well as a total ill-being scale composed of the combination of the four forms of ill-being. This led to the testing of 55 path models for each age group for each hypothesis. For each path model, hierarchical multiple regression was performed by first factoring out blocks of all relevant parent and child demographics including the responding parent's age, gender, education, ethnicity, family median income, and BMI, and the child's age and gender and then including the path links in the hierarchical regression.

4.1. Hypothesis 1: Does unhealthy eating predict Ill-being?

Fig. 1 indicated that children, preteens, and teenagers (as well as their parents) were consuming unhealthy foods at a high rate with the “average” participant consuming unhealthy foods anywhere from two to three times a week to nearly once a day. In addition, as one would predict that unhealthy eating would impact body weight, with so much consumption of junk food, sweets, fried foods, fast food meals, and regular sodas, all of which contain large numbers of calories and fats, it was hardly surprising that 66% of children, 52% of preteens and 38% of teenagers were either overweight or at risk of being obese. When the model that predicted a direct path from unhealthy eating to ill-being was tested—after factoring out all relevant parent and child demographics including parent BMI as well as total daily technology usage and each individual type of daily technology usage—differing results were found in the three age groups. For the young children, total ill-being, psychological issues, and attention problems were predicted by increased unhealthy eating regardless of the type of daily technology use being factored out. For physical problems, factoring out total technology use, daily music, and daily television viewing removed the statistical effect of unhealthy eating but no other technologies did so. Finally, factoring out any technology use rendered the impact of unhealthy eating statistically not significant.

In contrast, when preteens were examined with the path model, removing daily technology use did not affect the statistically significant impact of unhealthy eating on all forms of ill-being. However, this was not the case for teenagers where removing the impact of daily technology use on ill-being effectively removed the impact of unhealthy eating except for attention problems and a few of the paths for total ill-being including daily online use,

computer use, and IM/Chat use. Thus, overall, unhealthy eating did significantly predict ill-being for each age group although in some cases, this was moderated by technology use.

4.2. Hypothesis 2: Does lack of physical activity predict Ill-being?

According to the Centers for Disease Control and Prevention (CDC, 2013c), children and adolescents need 1 h or more of physical activity each day. Parents were asked to indicate the amount of daily physical activity for their child, preteen, or teenager on a 10-point scale. Responses were grouped into “acceptable” which included any amount 1 h a day or more and “unacceptable” which included any amount less than 1 h a day and the results indicated that only 59% of children, 45% of preteens and 43% of teenagers fell in the “acceptable” range [$\chi^2(df = 2) = 20.06, p < .001$]. When the path model was tested for Hypothesis 2—which included examining if daily physical activity predicted ill-being after factoring out parent and child demographics as well as daily media and technology usage—the results differed by age group. For children, essentially factoring out daily technology usage moderated the negative impact of the lack of physical activity on ill-being. For preteens, however, this was true with the exception of one form of ill-being where factoring out daily media and technology use did not moderate the impact of lack of physical activity on behavior problems. Thus, the less daily physical activity, the more behavior problems were evident in preteens. The biggest surprise was that technology use by teenagers did not moderate the impact of lack of physical activity on total ill-being, psychological issues, behavior problems, and physical problems with the exception of the moderating effect of five of the 10 technologies on predicting physical problems from lack of physical activity: being online, using a computer, e-mailing, watching TV/DVDs and playing with technological toys. Technology use proved to be a moderator for the impact of lack of physical activity on attention problems.

Overall, this suggests for teenagers the lack of physical activity has a direct link to ill-being and for preteens it has a direct link to behavior problems but there is no direct link for lack of physical activity with ill-being for children at all. One issue that might predict lack of physical activity is the presence of a “technococoon” (Weil & Rosen, 1998) where they have a wealth of technologies available in their bedrooms. Table 5 indicates that percentage of each age group who has certain technologies including cell phones, music players, televisions, computers, and gaming consoles. As can be seen, there is an increasing percentage of ownership from children to preteens to teens with the majority of teens and preteens possessing many technologies. Interestingly, more than half of the children had a television in their bedroom and either handheld video games or video game consoles. A series of analyses were performed to determine the potential relationship between technococoons or technology ownership and lack of physical activity. Only one significant relationship was found with children having their own laptop computer showing less physical activity than children who did not have their own laptop. However, given the small percentage of children with their own laptop (5%), this result should be looked at as suspect. Overall, however, the explanation that living in a technococoon may be responsible for the lack of physical activity among children, preteens, and teenagers.

It is interesting to note that taken on a macro developmental level, the health of children and preteens appears to be more related to eating habits while the health of teenagers is less related to eating. In contrast, children's health was strongly related to daily physical activity while for preteens physical activity predicted only behavior problems and for teenagers physical activity predicted all forms of ill-being other than attention problems. The former may be a function of the fact that more children were assessed as overweight or at risk for obesity, followed by preteens and then teenagers while physical activity showed the opposite trend with teenagers demonstrating less physical activity than preteens who, in turn, were less physically active than teenagers.

4.3. Hypothesis 3: Does overuse of technology predict Ill-being?

The main question in pursuing this study was: After accounting for the impact of parent and child demographics (including parent BMI), unhealthy eating and lack of physical exercise on ill-being would the use of technology in general, or any specific technologies, predict ill-being among children, preteens, and teenagers? The results of Hypothesis 3 testing (see Table 4) suggested that technology use did predict ill-being. Those children who used more technology demonstrated more total ill-being as well as more attention problems and physical problems. Only the use of two technologies—music players and technological toys—predicted more ill-being for children. In contrast, for preteens, while total technology use did predict more ill-being and more physical problems, several specific technology uses did predict ill-being including the use of e-mail, cell phones, IM/chat, video games, and technological toys, which predicted total ill-being and at least one specific type of ill-being.

When examining the impact of technology use on ill-being for teenagers, a strong pattern emerged. Even after factoring out demographics, unhealthy eating, and lack of physical activity, total daily technology use predicted total ill-being as well as all four types of ill-being. Further, increased daily use of most individual technologies significantly predicted total ill-being, psychological issues and attention problems with roughly half predicting physical problems. Thus, it appears that for children and preteens, overall technology use may be the culprit in ill-being, although for preteens some specific technologies—video games, cell phone, email, IM/chat, and technological toys—did predict ill-being in one form or another. For teenagers, however, it appears that the culprit in predicting ill-being of any type is primarily technology and that outside of behavior problems it appears that overuse of any technology significantly predicts ill-being.

4.4. Implications

The American Academy of Pediatrics recommends no screen time for children under the age of 2 and limited screen time for children in general. There are no similar stipulations for preteens or teenagers who appear, according to the data from this study, to be using technology many hours each day. The current study indicates that regardless of the demographic makeup of either the parent or the child, the child's eating habits, or the child's lack of physical activity, the use of technology may be a potential cause of poorer health whether that is defined as psychological issues, behavior problems, attention problems, or physical problems. In addition, while it appears that simply using more technology each day may negatively impact children and preteens, the use of technology has its most profound

effect on teenagers. While preteens are negatively impacted by the overuse of video gaming, electronic communication, and technological toys; teenagers who overuse *any technology* appear to have their health negatively impacted.

This suggests that it is not sufficient for parents to urge their children to eat better and to exercise more in order to attain better health. Study results indicate that it is also important for parents to set limits and boundaries with their children, preteens, and teenagers concerning the time they spend each and every day using technology. We found it particularly troubling that more than half the parents self-reported that their child, preteen, or teenager lived in a "technococoon" (Weil & Rosen, 1998) with teenagers specifically being surrounded by a multitude of their personal bedroom or mobile technologies. The fact that more than half of all children had a television in their bedroom, along with their choice of video game platforms, likely also in their bedrooms, was further validation that parents need to set better boundaries on technology use. Evidence abounds that having technology in the bedroom negatively impacts aggression, eating habits, and school difficulties (Strasburger et al., 2010) as well as sleep habits (Cain & Gradisar, 2010).

What can parents do to counter the problematic impact of increased screen time? In a meta analysis, Maniccia, Davison, Marshall, Manganello, and Dennison (2011) assessed the impact of intervention programs that encouraged parents and children to develop their own screen time plan, by helping families modify their home environment by establishing screen time restrictions, or providing opportunities for other activities, particularly in promoting physical activities. Overall, the results indicated a small but statistically significant effect on reducing screen time about which the authors conclude, "Even modest effects could result in a positive change in the health status of the population given the large number of children who use screen media and the increasing amount of time children spend with media" (p. e207).

In addition, we found it concerning that so few children, preteens, and teenagers spent even 1 h each day doing some form of physical activity. Most troubling was the impact of the lack of physical activity on preteen behavior problems and on nearly all forms of ill-being for teenagers. This suggests that our preteens and teenagers need help in reducing screen time in favor of physical activity. This presents a dual opportunity for parents and educators to help improve the health of American preteens and teenagers, a large portion who were found to be overweight or at risk for being obese. Pardo et al. (2013) reviewed dozens of studies providing school intervention strategies to increase physical activity and offered suggestions for schools to implement successful physical activity programs. On the home front, in a recent article Shearer and Moore (2013) describe behavioral interventions designed to increase physical activities of adolescents, most of which are independent of location and can be implemented in the home. Regardless of the location, it is clear that increasing physical activity, particularly among preteens and teenagers, is critical for helping reduce ill-being and increase health.

Finally, one strong contribution of this study is an assessment of precisely which technologies appear to be instrumental in predicting ill-being. Although no specific technologies, other than perhaps music and technological toys, appeared to be critical in

predicting ill-being in children, several technologies were significant predictors for preteens and many more technologies were significant predictors for teenagers. These results can be used to pinpoint intervention strategies with careful attention paid to video gaming and electronic communication among preteens and online time, electronic communication, and video gaming among teenagers.

4.5. Limitations

This study has several limitations. First, although it uses path analysis, which can be stretched to assume causality, it is really a simple correlational study. However, the results paralleled what others have found in separate studies with children and adolescents and this comprehensive study was able to provide comparisons and contrasts between children of different ages. Second, the study has a statistical limitation in that so many inferential tests were computed at the .05 significance level that one in 20 would be expected to be significant by chance. However, the pattern of results suggests a coherent picture for each age group that differed by the independent variable of technology type as well as by the dependent variable of the type of ill-being. This suggested that it was important to perform multiple regressions separately for each technology type and each form of ill-being to gain a true understanding of what technologies were affecting what forms of health. Third, parents answered all questions for the children, preteens, and teenagers rather than having them answer on their own. There is no way to tell if the parents were inflating or minimizing any of their responses, particularly with respect to sensitive issues such as screen time and eating habits. This is a limitation although the data on screen time and technococoons match other research data collected on the children themselves.

Another limitation is inherent in the way screen time was measured. In a recent study, Junco (2013) showed that assessing screen usage through estimated time measurements is inherently flawed by actually tracking people's computer usage and finding that the raw screen time estimates were seriously overstated. Although this study examined daily screen time, future studies of the impact of media usage might consider using a frequency scale to account for the current habit of quickly checking in with most technology on a smartphone (Rosen, Whaling, Carrier, Cheever, & Rokkum, 2013). Another limitation is the broad categories used in assessing screen time. Knowing that someone spends a certain amount of hours per day online does not indicate anything about the types of activities and those activities themselves may be critical in impacting health. Along the same lines, the current study only assessed raw daily screen time with television, DVDs and video games, but did not assess the content of that screen time. With many studies suggesting that violent content is responsible for psychological issues and behavior problems, this would be important to refine the results of the study.

5. Conclusions

Although using a broad definition of screen time, this study has illuminated those general screen activities that appear to be predictive of poor health above and beyond the impact of reduced physical activity and poor eating habits across three age groups. Overall, the results of this study suggest that technology does appear to have an independent effect on health that differs between children, preteens, and teenagers. These results suggest that helping

children eat more healthy meals and snacks while at the same time increasing their physical activity is not the sole solution to helping them attain good health. In addition, parents need to be aware of the potentially harmful effects of technology and implement strategies to help their children moderate their own usage to reduce their overall screen time.

Acknowledgments

Thanks to the George Marsh Applied Cognition Laboratory for their work on this project. Sincere appreciation to the National Institutes of Health, U.S. Department of Health and Human Services, Minority Biomedical Research Support Research Initiative for Scientific Enhancement Program (MBRS-RISE Grant No GM008683) for supporting Mr. Jose Lara-Ruiz.

References

Anderson SE, Economos CD, Must A. Active play and screen time in US children aged 4 to 11 years in relation to sociodemographic and weight status characteristics: A nationally representative cross-sectional analysis. BMC Public Health. 2008; 8:366–378. [PubMed: 18945351]

Anderson SE, Whitaker RC. Household routines and obesity in US preschool-aged children. Pediatrics. 2010; 125(3):420–428. [PubMed: 20142280]

Arora, T.; Hosseini-Araghi, M.; Bishop, J.; Yao, GL.; Thomas, GN.; Taheri, S. The complexity of obesity in UK adolescents: relationships with quantity and type of technology, sleep duration and quality, academic performance and aspiration. Pediatric Obesity. 2012. http://dx.doi.org/10.1111/j.2047-6310.2012.00119.x

Babey SH, Hastert TA, Wolstein J. Adolescent sedentary behaviors: Correlates differ for television viewing and computer use. Journal of Adolescent Health. 2013; 52(1):70–76. [PubMed: 23260837]

Barnett TA, O'Loughlin J, Sabiston CM, Karp I, Bélanger M, Van Hulst A, et al. Teens and screens: The influence of screen time on adiposity in adolescents. American Journal of Epidemiology. 2010; 172(3):255–262. [PubMed: 20616201]

Belanger RE, Akre C, Berchtold A, Michaud PA. A U-shaped association between intensity of Internet use and adolescent health. Pediatrics. 2011; 127:e330–e335. [PubMed: 21242218]

Bickham D, Walls CE, Shrier LA, Blood EA, Rich M. Characteristics of screen media use associated with higher body mass index in young adolescents. Platform Abstracts. 2012; 50:S11.

Boone JE, Gordon-Larsen P, Adair LS, Popkin BM. Screen time and physical activity during adolescence: longitudinal effects on obesity in young adulthood. International Journal of Behavioral Nutrition & Physical Activity. 2007; 4:426–436.

Brown JD, Bobkowski PS. Older and newer media: Patterns of use and effects on adolescents' health and well-being. Journal of Research on Adolescence. 2011; 21(1):95–113.

Bushman BJ, Gibson B. Violent video games cause an increase in aggression long after the game has been turned off. Social Psychological and Personality Science. 2011; 2(1):29–32.

Cain N, Gradisar M. Electronic media use and sleep in school-aged children and adolescents: A review. Sleep Medicine. 2010; 11(8):735–742. [PubMed: 20673649]

Cameron AJ, van Stralen MM, Brug J, Salmon J, Bere E, ChinAPaw MJM, et al. Television in the bedroom and increased body weight: Potential explanations for their relationship among European schoolchildren. Pediatric Obesity. 2012; 8:130–141. [PubMed: 23239631]

Carli VV, Durkee TT, Wasserman DD, Hadlaczky GG, Despalins RR, Kramarz EE, et al. The association between pathological Internet use and comorbid psychopathology: A systematic review. Psychopathology. 2013; 46(1):1–13. [PubMed: 22854219]

Carrier LM, Cheever NA, Rosen LD, Benitez S, Chang J. Multitasking across generations: Multitasking choices and difficulty ratings in three generations of Americans. Computers in Human Behavior. 2009; 25:483–489.

Casiano H, Kinley DJ, Katz LY, Chartier MJ, Sareen J. Media use and health outcomes in adolescents: Findings from a nationally representative survey. Journal of the Canadian Academy of Adolescent Psychiatry. 2012; 21(4):296–301.

CDC. Childhood obesity facts. 2013a. Retrieved <http://www.cdc.gov/healthyyouth/obesity/facts.htm>

CDC. Body mass index. 2013b. Retrieved <http://www.cdc.gov/healthyweight/assessing/bmi>

CDC. How much physical activity do children need?. 2013c. Retrieved <http://www.cdc.gov/physicalactivity/everyone/guidelines/children.html>

Committee on Public Education. Children, adolescents, and television. Pediatrics. 2001; 107:423–426. [PubMed: 11158483]

Cox R, Skouteris H, Rutherford L, Fuller-Tyszkiewicz M, Dell'Aquila D, Hardy L. Television viewing, television content, food intake, physical activity and body mass index: A cross-sectional study of preschool children aged 2–6 years. Health Promotion Journal of Australia. 2012; 23:58–62. [PubMed: 22730942]

Cristakis DA, Moreno MM, Jelenchick L, Myaing MT, Zhou C. Problematic Internet usage in US college students: A pilot study. BMC Medicine. 2011; 9(77)

Cristakis DA, Zimmerman FJ, DiGiuseppe DL, McCarty CA. Early television exposure and subsequent attentional problems in children. Pediatrics. 2004; 113(4):708–713. [PubMed: 15060216]

Cuihua S, Williams D. Unpacking time online: Connecting Internet and massively multiplayer online game use with psychosocial well-being. Communication Research. 2011; 38(1):123–149.

de Jong E, Visscher TLS, HiraSing RA, Heymans MW, Seidell JC, Renders CM. Association between TV viewing, computer use and overweight, determinants and competing activities of screen time in 4- to 13-year-old children. International Journal of Obesity. 2013; 37:47–53. [PubMed: 22158265]

Do YK, Shin E, Bautista A, Foo K. The associations between self-reported sleep duration and adolescent health outcomes: What is the role of time spent on Internet use? Sleep Medicine. 2013; 14:195–200. [PubMed: 23068781]

DuPaul GJ, Power TJ, Anastopoulos AD, Reid R, McGoey KE, Ikeda MJ. Teacher ratings of attention deficit hyperactivity disorder symptoms: Factor structure and normative data. Psychological Assessment. 1997; 9(4):436–444.

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. JAMA Pediatrics. 2013; 167(3):223–229. [PubMed: 23303439]

Fitzpatrick C, Pagani LS, Barnett TA. Early childhood television viewing predicts explosive leg strength and waist circumference by middle childhood. International Journal of Behavioral Nutrition and Physical Activity. 2012; 9:87. Retrieved <http://www.ijbnpa.org/content/9/1/87>. [PubMed: 22793018]

Foley LS, Maddison R, Jiang Y, Marsh S, Olds T, Ridley K. Presleep activities and time of sleep onset in children. Pediatrics. 2013; 131:276–282. [PubMed: 23319532]

Gentile DA, Choo H, Liau A, Sim T, Li D, Fung D, et al. Pathological video game use among youths: A two-year longitudinal study. Pediatrics. 2011; 127(2):E319–E329. [PubMed: 21242221]

Gentile DA, Swing EL, Lim CG, Khoo A. Video game playing, attention problems, and impulsiveness. Psychology of Popular Media Culture. 2012; 1(1):62–70.

Gundogar AA, Bakim BB, Ozer OA, Karamustafalioglu OO. The association between Internet addiction, depression and ADHD among high school students. European Psychiatry. 2012; 271 http://dx.doi.org/10.1016/S0924-9338(12)74199-8.

Gunter WD, Daly K. Causal or spurious: Using propensity score matching to detangle the relationship between violent video games and violent behavior. Computers in Human Behavior. 2012; 28(4): 1348–1355.

Hamblin, J. Look how quickly the U S got fat (1985–2010 animated map). 2013. Retrieved <http://www.theatlantic.com/health/archive/2013/04/look-how-quickly-the-us-got-fat-1985-2010-animated-map/274878/>

Hamer M, Stamatakis E, Mishra G. Psychological distress, television viewing, and physical activity in children aged 4 to 12 years. Pediatrics. 2009; 123:1263–1268. [PubMed: 19403489]

Hasan Y, Bègue L, Scharkow M, Bushman BJ. The more you play, the more aggressive you become: A long-term experimental study of cumulative violent video game effects on hostile expectations and aggressive behavior. Journal of Experimental Social Psychology. 2013; 49(2):224–227.

Hellmich, N. USA is fattest of 33 countries, report says. 2010. Retrieved <http://usatoday30.usatoday.com/news/health/weightloss/2010-09-24-fatusa24_ST_N.htm>

Holtz P, Appel M. Internet use and video gaming predict problem behavior in early adolescence. Journal of Adolescence. 2011; 34:49–58. [PubMed: 20303580]

Iowa Department of Public Education. Overweight, screen time, and physical activity: A portrait of Iowa children. 2008. Retrieved <http://www.idph.state.ia.us/iowansfitforlife/common/pdf/fact_sheet.pdf>

Junco R. Comparing actual and self-reported measures of Facebook use. Computers in Human Behavior. 2013; 29(3):626–631.

Ko CH, Yen JY, Yen CF, Chen CS, Chen CC. The association between Internet addiction and psychiatric disorder: A review of the literature. European Psychiatry. 2012; 27:1–8. [PubMed: 22153731]

Kotikalapudi R, Chellappan S, Montgomery F, Wunsch D, Lutzen K. Associating Internet usage with depressive behavior among college students. Technology and Society Magazine, IEEE. 2012; 31(4):73–80.

Lachs MS, Feinstein AR, Cooney LM, Drickamer MA, Marottoli RA, Pannill FH, et al. A simple procedure for general screening for functional disability in elderly patients. Annals of Internal Medicine. 1990; 112:699–706. [PubMed: 2334082]

Landhuis CE, Poulton R, Welch D, Hancox RJ. Does childhood television viewing lead to attention problems in adolescence? Results from a prospective longitudinal study. Pediatrics. 2007; 120:532–537. [PubMed: 17766526]

Lemmens JS, Valkenburg PM, Peter J. The effects of pathological gaming on aggressive behavior. Journal of Youth Adolescence. 2011; 41:38–47. [PubMed: 20549320]

Maniccia DM, Davison KK, Marshall SJ, Manganello JA, Dennison BA. A meta-analysis of interventions that target children's screen time for reduction. Pediatrics. 2011; 128(1):e193–e201. [PubMed: 21708797]

Martin, K. Electronic overload: The impact of excessive screen use on child and adolescent health and wellbeing. Perth, Western Australia: Department of Sport and Recreation; 2011.

Messias E, Castro J, Saini A, Usman M, Peeples D. Sadness, suicide, and their association with video game and Internet overuse among teens: Results for the Youth Risk Behavior Survey 2007 and 2009. Suicide and Life-Threatening Behavior. 2011; 41(3):307–315. [PubMed: 21463355]

Mistry KB, Minkovitz DM, Srobino DM, Borzekowski DLG. Children's television exposure and behavioral and social outcomes at 5.5 years: Does timing of exposure matter? Pediatrics. 2007; 120:762–769. [PubMed: 17908763]

National Center for Health Statistics. Health, United States, 2011: With special features on socioeconomic status and health. Hyattsville, MD: U.S. Department of Health and Human Services; 2012. 2012

Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. Journal of the American Medical Association. 2012; 307(5):483–490. [PubMed: 22253364]

Pagani LS, Fitzpatrick C, Barnett TA, Dubow E. Prospective associations between early childhood television exposure and academic, psychosocial, and physical well-being by middle childhood. Archives of Pediatrics and Adolescent Medicine. 2010; 164(5):425. [PubMed: 20439793]

Page AS, Cooper AR, Griew P, Jago RP. Children's screen viewing is related to physiological difficulties irrespective of physical activity. Pediatrics. 2010; 126(5):1011–1017.

Pardo BM, Bengoechea EG, Lanaspa EG, Bush PL, Casterad JZ, Clemente JAJ, et al. Promising school-based strategies and intervention guidelines to increase physical activity of adolescents. Health Education Research. 2013; 28(3):523–538. [PubMed: 23515117]

Park S, Hong KEM, Park EJ, Ha KS, Yoo HJ. The association between problematic Internet use and depression, suicidal ideation and bipolar disorder symptoms in Korean adolescents. Australian & New Zealand Journal of Psychiatry. 2012; 47(2):153–159. [PubMed: 23047959]

Parkes A, Sweeting H, Wight D, Henderson M. Do television and electronic games predict children's psychosocial adjustment? Longitudinal research using the UK Millennium Cohort Study. Archives of Disease in Childhood. 2013; 98(5):341–348. [PubMed: 23529828]

Ray M, Jat KR. Effect of electronic media on children. Indian Pediatrics. 2010; 47:561–568. [PubMed: 20683108]

Rideout, V.; Foehr, UG.; Roberts, DF. Generation M2: Media in the lives of 8–18 year-olds. Menlo Park, CA: The Henry J. Kaiser Family Foundation; 2010.

Romer D, Bagdasarov Z, More E. Older versus newer media and the well-being of United States youth: Results From a national longitudinal panel. Journal of Adolescent Health. 2013; 52(5):613–619. [PubMed: 23375827]

Rosen LD, Whaling K, Carrier LM, Cheever NA, Rokkum J. The media and technology usage and attitudes scale: An empirical investigation. Computers in Human Behavior. 2013; 29(6):2501–2511.

Rosen LD, Whaling K, Rab S, Carrier LM, Cheever NA. Is Facebook creating “iDisorders”? The link between clinical symptoms of psychiatric disorders and technology use, attitudes and anxiety. Computers in Human Behavior. 2013; 29:1243–1254.

Rosenberg, M. Society and the adolescent self-image. Princeton, NJ: Princeton University Press; 1965.

Scott J, Porter-Armstrong AP. Impact of multiplayer online role-playing games upon the psychosocial well-being of adolescents and young adults: Reviewing the evidence. Psychiatry Journal. 2013:8. Article ID 464685. 10.1155/2013/464685.

Shearer, EM.; Moore, BA. The effects of physical activity on the physical and psychological health of adolescents. In: O'Donohue, WT.; Benuto, LT., editors. Handbook of adolescent health psychology. New York, NY: 2013. p. 165-174.

Springer 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. Journal of Adolescent Health. 2010; 47(3):309–311. [PubMed: 20708572]

Strasburger VC, Jordan AB, Donnerstein E. Health effects of media on children and adolescents. Pediatrics. 2010; 125:756–767. [PubMed: 20194281]

Swing EL, Gentile DA, Anderson CA, Walsh DA. Television and video game exposure and the development of attention problems. Pediatrics. 2010; 126:214–221. [PubMed: 20603258]

Tandon PS, Zhou C, Lozano P, Christakis DA. Preschoolers' total daily screen time at home and by type of day care. Pediatrics. 2011; 158:297–300.

Tandon PS, Zhou C, Sallis JF, Cain KL, Frank LD, Saelens BE. Home environment relationships with children's physical activity, sedentary time, and screen time by socioeconomic status. International Journal of Behavioral Nutrition and Physical Activity. 2012; 9:88. [PubMed: 22835155]

Taylor, H. Healthy and unhealthy behavior and lifestyle trends: No significant change in 2011 in proportion of adults who are obese, smoke or wear seatbelts. Harris Interactive. 2011. Retrieved <http://www.harrisinteractive.com/NewsRoom/HarrisPolls/tabid/447/mid/1508/articleId/786/ctl/ReadCustom%20Default/Default.aspx>

Torsheim T, Eriksson L, Schnohr CW, Hansen F, Bjarnason T, Välimaa R. Screen-based activities and physical complaints among adolescents from the Nordic countries. BMC Public Health. 2010; 10:324–331. [PubMed: 20534116]

U.S. Census Bureau. American FactFinder. 2000. http://factfinder.census.gov/home/saff/main.html?_lang=en

U.S. Census Bureau. American community survey. 2006. http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=Search&_langx=585en&_sse=on&geo_id=05000US06037&_county=Los+Angeles+County

Weil, MM.; Rosen, LD. TechnoStress: Coping with technology @Work @Home @Play. New York: John Wiley and Sons; 1998.

Young, KS. Caught in the net: How to recognize Internet addiction and a winning strategy for recovery. New York: John Wiley & Sons; 1998.

Zimmerman FJ, Cristakis DA. Associations between content types of early media exposure and subsequent attentional problems. Pediatrics. 2007; 120:986–992. [PubMed: 17974735]

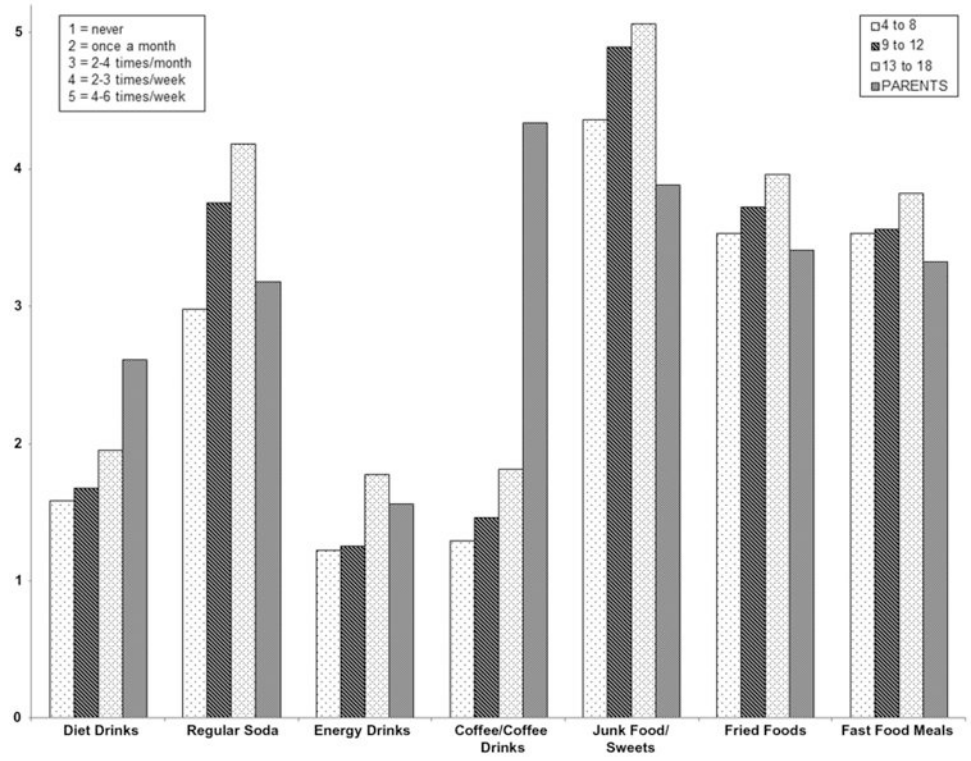

Fig. 1.
Junk food consumption by children (4–8), preteens (9–12), teenagers (13–18) and parents.

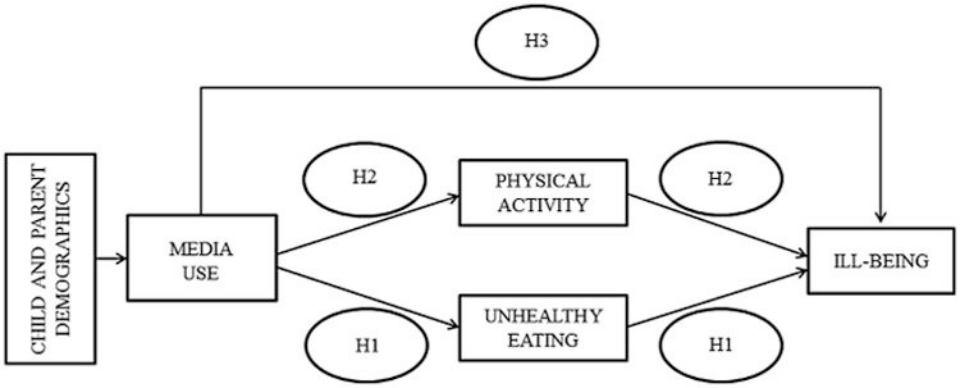

Fig. 2.

Path model predictions: predicting ill-being from unhealthy eating after factoring out media use and demographics (Hypothesis 1); predicting ill-being from physical activity after factoring out media use and demographics (Hypothesis 2); and predicting ill-being from media use after factoring out demographics, unhealthy eating and physical activity (Hypothesis 3).

Table 1

Daily media usage mean (standard deviation) for children (n = 338), preteens (n = 316), and teens (n = 376) shown in hours: minutes.

Media/technology usage item	4- to 8-year-olds	9- to12-year-olds	13- to 18-year-olds	F-Score
Online	0:27 (0:44)	1:01 (1:11)	1:24 (1:53)	128.89***
Using computer (not online)	0:23 (0:38)	0:53 (1:07)	1:37 (1:49)	96.37***
E-Mail	0:06 (0:25)	0:22 (1:02)	0:56 (1:49)	71.05***
IM/Chat	0:04 (0:22)	0:24 (1:19)	1:21 (2:35)	84.40***
Telephone	0:20 (0:37)	0:41 (0:55)	1:14 (1:47)	64.54***
Text messaging	0:07 (0:42)	0:41 (1:37)	2:25 (3:19)	135.33***
Video games	0:50 (1:05)	1:12 (1:21)	1:06 (2:01)	8.24***
Music	0:42 (0:46)	1:16 (1:44)	2:49 (2:56)	125.45***
Television	2:05 (1:28)	1:52 (1:27)	1:55 (1:45)	1.52
Tech toys	0:59 (1:01)	0:41 (0:55)	0:41 (1:09)	9.04***
TOTAL TECH[a]	7:11 (4:45)	9:57 (7:34)	18:28 (11:30)	165.79***

[a]Total hours of media/technology truncated to 3 standard deviations above mean and all total hours above that number were changed to exactly 3 standard deviations above the mean.

***$p < .001$.

Table 2

Regression coefficients (beta weights) for unhealthy eating predicting Ill-being after factoring out demographics and technology use (Hypothesis 1).

Technology type factored out	Total Ill-being	Psychological issues	Behavior problems	Attention problems	Physical problems
4- to 8-Year-olds					
Total Tech	.138*	.124*	ns	.16*	ns
Online	.176**	.151*	ns	.180**	.156*
Computer	.196***	.162**	ns	.208***	.146*
Email	.182**	.145*	ns	.202***	.131*
IM/Chat	.188**	.154*	ns	.201***	.139*
Phone	.185**	.147*	ns	.204***	.137*
Text	.175**	.134*	ns	.196***	.130*
Video Games	.178**	.146*	ns	.193**	.135*
Music	.148*	.137*	ns	.173**	ns
TV/DVD	.166**	.150*	ns	.191**	ns
Tech toys	.175**	.149*	ns	.189**	.130*
9- to 12-Year-olds					
Total Tech	.203**	.151*	ns	.19**	.146*
Online	.226***	.158*	.137*	.226***	.170**
Computer	.236***	.157*	.160*	.222***	.183**
Email	.204***	.129*	ns	.204**	.164**
IM/Chat	.220*	.154*	ns	.209***	.177**
Phone	.201***	.136*	ns	.200**	.154*
Text	.232***	.171**	.14*	.214***	.175**
Video games	.222***	.158*	.131*	.191**	.182**
Music	.232***	.176**	.143*	.192**	.181**
TV/DVD	.262***	.204**	.146*	.228***	.203**
Tech toys	.238***	.166**	.136*	.203***	.201***
13- to 18-Year-olds					

Technology type factored out	Total Ill-being	Psychological issues	Behavior problems	Attention problems	Physical problems
Total Tech	ns	ns	ns	ns	ns
Online	.138*	ns	ns	.224***	ns
Computer	.128*	ns	ns	.221***	ns
Email	ns	ns	ns	.184**	ns
IM/Chat	.127*	ns	ns	.212***	ns
Phone	ns	ns	ns	.184**	ns
Text	ns	ns	ns	.209***	ns
Video games	ns	ns	ns	.141*	ns
Music	ns	ns	ns	.207**	ns
TV/DVD	ns	ns	ns	.217***	ns
Tech toys	ns	ns	ns	.167**	ns

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 3

Regression coefficients (beta weights) for physical activity predicting Ill-being after factoring out demographics and technology use (Hypothesis 2).

Technology type factored out	Total Ill-being	Psychological issues	Behavior problems	Attention problems	Physical problems
4- to 8-Year-olds					
Total Tech	ns	ns	ns	ns	ns
Online	ns	ns	ns	ns	ns
Computer	ns	ns	ns	ns	ns
Email	ns	ns	ns	ns	ns
IM/Chat	ns	ns	ns	ns	ns
Phone	ns	ns	ns	ns	ns
Text	ns	ns	ns	ns	ns
Video games	ns	ns	ns	ns	ns
Music	−.137*	ns	ns	ns	−.128*
TV/DVD	ns	ns	ns	ns	ns
Tech toys	ns	ns	ns	ns	ns
9- to 12-Year-olds					
Total Tech	ns	ns	−.206**	ns	ns
Online	ns	ns	−.167*	ns	ns
Computer	ns	ns	−.161*	ns	ns
Email	ns	ns	−.176**	ns	ns
IM/Chat	ns	ns	−.175**	ns	ns
Phone	ns	ns	−.167**	ns	ns
Text	ns	ns	−.174**	ns	ns
Video games	ns	ns	−.189**	ns	ns
Music	ns	ns	−.189**	ns	ns
TV/DVD	ns	ns	−.178**	ns	ns
Tech Toys	ns	ns	−.202**	ns	ns
13- to 18-Year-olds					
Total Tech	−.215***	−.199***	−.176**	ns	−.153*

Technology type factored out	Total Ill-being	Psychological issues	Behavior problems	Attention problems	Physical problems
Online	−.154*	−.156*	−.104*	ns	ns
Computer	−.139*	−.142*	−.133*	ns	ns
Email	−.158*	−.160**	−.140*	ns	ns
IM/Chat	−.166**	−.165**	−.144*	ns	−.124*
Phone	−.188**	−.182**	−.154*	ns	−.135*
Text	−.175**	−.171**	−.149*	ns	−.130*
Video games	−.187**	−.183**	−.161*	ns	−.124*
Music	−.192**	−.181**	−.157*	ns	−.153*
TV/DVD	−.151*	−.149*	−.143	ns	ns
Tech toys	−.151*	−.151*	−.141*	ns	ns

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Comput Human Behav. Author manuscript; available in PMC 2015 February 23.

Table 4

Regression coefficients for technology use predicting Ill-being after factoring out demographics, unhealthy eating and lack of physical activity (Hypothesis 3).

Technology type	Total Ill-being	Psychological issues	Behavior problems	Attention problems	Physical problems
4- to 8-Year-olds					
Total Tech	.181**	ns	ns	.157*	.159*
Online	ns	ns	ns	ns	ns
Computer	ns	ns	ns	ns	ns
Email	ns	ns	ns	ns	ns
IM/Chat	ns	ns	ns	ns	ns
Phone	ns	ns	ns	ns	ns
Text	ns	ns	ns	ns	ns
Video games	ns	ns	ns	ns	ns
Music	.233***	ns	.190**	.183**	.174**
TV/DVD	ns	ns	ns	ns	.134*
Tech toys	.178**	ns	ns	.180**	.166**
9- to 12-Year-olds					
Total Tech	.166*	ns	ns	ns	.206**
Online	ns	ns	ns	ns	ns
Computer	ns	ns	ns	ns	ns
Email	.196***	.197**	ns	ns	.182**
IM/Chat	.124*	ns	ns	ns	.128*
Phone	.208***	.169**	ns	ns	.227***
Text	ns	ns	ns	ns	.153*
Video games	.177**	ns	ns	.163*	.157*
Music	ns	ns	ns	ns	.151*
TV/DVD	ns	ns	ns	ns	ns
Tech toys	.125*	ns	.131*	.158**	ns
13- to 18-Year-olds					

Technology type	Total Ill-being	Psychological issues	Behavior problems	Attention problems	Physical problems
Total Tech	.374***	.290***	.198**	.358***	.235***
Online	.182**	.190**	ns	.131*	ns
Computer	.179**	.150*	ns	ns	.134*
Email	.221***	.236***	ns	.223***	ns
IM/Chat	.240***	.215***	ns	.216***	.157*
Phone	.242***	.204**	ns	.260***	.141*
Text	.140*	ns	ns	.130*	ns
Video games	.238***	.218**	ns	.314***	ns
Music	.195**	.144*	ns	ns	.196**
TV/DVD	ns	ns	ns	ns	ns
Tech toys	ns	ns	ns	.210***	ns

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 5

Percentages of each age group that has or own specific technologies.

Media/technology	4–8 (%)	9–12 (%)	13–18 (%)	χ^2-score
Cell with Internet access	3	13	42	170.10***
Cell w/o Internet access	8	40	47	131.00***
iPod or MP3 Player	24	66	87	280.02***
Television in bedroom	59	67	72	12.77**
Video game console	55	77	64	33.25***
Handheld video game	54	71	45	46.02***
Computer in bedroom	10	25	38	69.33***
Own laptop	5	16	32	84.12***

Note: Underlined percentage indicates that ownership was correlated with lack of physical activity with a χ^2 test ($p < .05$).

** $p < .01$.

*** $p < .001$.