

Article

## Teens, Health and Technology: A National Survey

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### Abstract

In the age of digital technology, as teens seem to be constantly connected online, via social media, and through mobile applications, it is no surprise that they increasingly turn to digital media to answer their health questions. This study is the first of its kind to survey a large, nationally-representative sample of teens to investigate how they use the newest digital technologies, including mobile apps, social networking sites, electronic gaming and wearable devices, to explore health topics. The survey covered the types of health topics teens most frequently search for, which technologies they are most likely to use and how they use them, and whether they report having changed their behaviors due to digital health information. In addition, this survey explores how the digital divide continues to impact adolescents. Results of this study indicate that teens are concerned about many health issues, ranging from fitness, sexual activity, drugs, hygiene as well as mental health and stress. As teens virtually always have a digital device at their fingertips, it is clear that public health interventions and informational campaigns must be tailored to reflect the ways that teens currently navigate digital health information and the health challenges that concern them most.

### Keywords

adolescents; digital technology; health; information-seeking

### Issue

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## 1. Introduction

### 1.1. *The Internet and Health Information-Seeking*

With the advent of digital technology, adolescents have become well-adjusted to using digital tools, such as the Internet. According to a 2015 Pew Research Center report, 92% of adolescents ages 12–17 report going online daily. In fact, adolescents and young adults have far surpassed all other age groups in Internet use. Relatedly, social networking also plays a large role in the lives of adolescents with 71% of teens reporting that they use more than one social networking site (Lenhart, 2015). A recent Common Sense Media report indicated that 45% of teens reported that they use social

networking sites daily. However, according to the report, daily social media use still lags far behind daily traditional media use (e.g., music and television) (Rideout, 2015).

When it comes to which topics teens search for online, a majority of research regarding adolescent online health information seeking has centered on sexual health. Keller, Labelle, Karimi, & Gupta (2002) reported that online information regarding sexual health is prevalent. Despite this finding, Mitchell, Ybarra, Korchmaros and Kosciw (2014) found that very few heterosexual youth search for sexual health information online. On the other hand, homosexual youth are far more likely to look up such information, with 78% of this demographic reporting that they had

searched for sexual health information online (Mitchell et al., 2014).

Rather than turn to the Internet, adolescents appear to turn to interpersonal sources when facing questions about more sensitive health topics. Only 17% of teens report using the Internet to search for topics that they may be uncomfortable discussing with others (such as sexual health) (Lenhart, 2010). Willingness to search for sensitive health information online also differs by age and gender. Girls, especially older girls, are far more likely to search for uncomfortable health topics online. On the other hand, younger boys (ages 12–13) were the least likely among adolescents to search for sensitive health topics (Lenhart, 2010). Rather, studies indicate that teens prefer to ask parents, teachers and friends about sensitive health questions, rather than search on the Internet (Gray, Klein, Noyce, Sesselberg, & Cantrill, 2005; Jones & Biddlecom, 2011).

However, adolescents' online health information seeking is by no means only restricted to the topic of sexual health. A 2010 Pew Research Center report indicated that 31% of youth ages 12–17 report looking up fitness-related information online, a slight increase from 28% in 2006. This study also indicates that teens searched for this information less frequently than adults, with a reported 38% of those over 18 seeking this information (Lenhart et al., 2010). In addition, a focus group study with adolescents indicated that adolescents search for a wide range of health topics on the Internet including sexual health, relationship health, specific medical conditions, violence, body image and nutrition (Skinner, Biscope, Poland, & Goldberg, 2003). However, there is a lack of recent studies indicating which health topics are searched for online by adolescents.

As with the Internet at large, adolescents also have access to a variety of health information via social networking sites (Lenhart, 2015). However, one study among low-income youth indicates that they may be very wary of using social networking sites for health-related questions, due to the lack of anonymity that these sites afford (Divecha, Divney, Ickovics, & Kershaw, 2012). The prior study was not conducted with a large or nationally representative sample. Thus, there remains a gap in research on adolescent use of social media for health.

### 1.2. Mobile and Wearable Technology for Health

A large percentage of adolescents use mobile media, with nearly 70% of youth ages 13–17 owning a smartphone (Nielsen, 2013). As more adolescents have access to mobile media through the use of smartphone technology, the potential to reach this demographic with mobile health information and applications also has grown. There are a wide variety of mobile health

applications readily available to adolescents. In 2011, there were 1,056 “Healthcare and Fitness” applications available in the Apple App Store (Liu, Zhu, Holroyd, & Seng, 2011). Nearly 37% of these apps were categorized as fitness apps or tracking apps (e.g., apps designed to track caloric intake) (Liu et al., 2011).

Recent years have seen a surge in *wearable* health tracking devices. Some studies have examined the use of wearable medical technology for chronic health conditions such as diabetes with promising results (Georga, Protopappas, Bellos, & Fotiadis, 2014). Most commercially available health trackers are geared toward fitness and exercise, obviously with promising effects on physical activity (Kranz et al., 2013). Unfortunately, adolescent use of mobile health applications and wearable health technology has not been assessed. Overall, there remains a gap in literature in regards to how adolescents use the Internet, mobile technology and wearable devices for health as well as which health topics adolescents frequently search for. Therefore, we proposed the following research questions to address in our national survey of adolescents use of technology for health: *how do adolescents use the Internet, mobile applications and wearable health devices to search for health information? Which health topics do adolescents most frequently search online?*

### 1.3. Sources of Health Information Online

When searching for health information online, adolescents often rely on easily accessible and convenient information. In one study of adolescent health information-seeking online, scholars noted that participants often began their searches by going to a search engine (e.g. Google). Adolescents who used search engines noted that the vast number of results generated through search queries made it quite difficult to choose a site or determine its credibility (Gray et al., 2005). When using search engines online to answer health-related questions, adolescents tend to choose between the first nine results, without searching further (Hansen, Derry, Resnick, & Richardson, 2003). Thus, adolescents' use of the Internet to search for health information may be limited in relation to their search heuristics and tactics. However, most studies regarding adolescent information-seeking tactics online have been conducted observationally or with smaller samples. To fill this gap in existing literature, we posed the following research question: *how do adolescents search for health information online?*

### 1.4. Digital Health Information and Behavior Change

Research has demonstrated the use of digital platforms to stage health behavior interventions among adolescents. A systematic review of Internet interventions

among adolescents and young adults revealed that by using tailored messaging and reminders to perform positive health behaviors along with an incentives-based approach, Internet interventions proved more successful at eliciting behavior change (Crutzen et al., 2010). Thus, scholarship demonstrates that health information found online can indeed be used to change adolescent health behavior.

In the USA, scholars and government officials have recently begun to research how such mobile applications can be used to assist teens in regards to health issues. For instance, the National Institute of Health reported the unveiling of *SmokefreeTXT*, a mobile application designed to help teens quit smoking (Daniels, 2012). Intervention studies have shown great potential of mobile-phone apps to lead to positive health outcomes (e.g., increased physical activity) (Ahtinen et al., 2009; Tsai et al., 2007). For example, one study also found that gamification and interactivity in a mobile application for adolescents with type 1 diabetes led to improvement in blood glucose monitoring among participants (Cafazzo, Casselman, Hamming, Katzman, & Palmert, 2012). Interestingly, the majority of these applications are still simple text-messaging services (Daniels, 2012; Levine, McCright, Dobkin, Woodruff, & Klausner, 2008; Rodgers et al., 2005).

These studies indicate that mobile applications may help promote positive health behaviors and behavior change among adolescents. However, little is known regarding how existing health information, found via the Internet and mobile applications impacts health choices of young people. In addition, most studies regarding adolescent health behavior change are conducted with smaller samples. Thus, a study with a large, nationally-representative sample would add to existing knowledge. Therefore, we asked the following research question: *how does health information found via the Internet and mobile applications impact adolescent health behavior?*

### 1.5. Adolescents and the Digital Divide

While adolescents now have greater access to the Internet and digital technology than ever before, access to digital information remains unequal. Youth who are also low income report going online less frequently. However, lower income adolescents are more likely to use social networking sites than higher income youth. Furthermore, there is a smaller divide between lower and higher income youth in regards to mobile access (Lenhart, 2012). While low-income youth are receiving greater access to the Internet and digital technology, there is still a large gap in how youth of different socio-economic groups use the Internet. Wealthier adolescents are more likely to use the Internet for information while poorer adolescents are more likely to use the Internet for entertainment (Peter & Valkenburg,

2006). However, research regarding how the digital divide and income inequality impacts adolescent health remains limited. Thus, the following research question was posed: *what are differences among youth of low, middle and high economic status regarding digital access and health topics?*

## 2. Methods

### 2.1. Participants

To study these research questions, we conducted a nationally-representative survey of 1,156 U.S. teens ages 13 to 18 years old, conducted among teens in English-speaking households from October 21 through November 9, 2014, and among teens in Spanish-dominant households in March 2015. Approximately half of the respondents were between the ages of 13 and 15 and half were between the ages of 16 and 19. 51% of adolescent respondents were male. The average annual household income of respondents was \$50,000 to \$59,000. The majority of respondents were White, non-Hispanic (56%),  $n = 604$ ; 22% ( $n = 241$ ) were Hispanic/Latino, 14% ( $n = 144$ ) Black, Non-Hispanic, and 9% reported other and mixed race, Non-Hispanic ( $n = 58$ ).

The survey was administered online by the GfK Group using members of its KnowledgePanel. Parental and teen consent were obtained, and the survey was offered in English or Spanish. GfK's KnowledgePanel is the first probability-based online research panel. Panel members are randomly recruited through address-based sampling methods (previously GfK relied on random-digit dialing methods). Households that are not already online are provided with notebook computers and access to the Internet if needed. The use of a probability-based sample means that the results are substantially more generalizable to the U.S. population than are results based on so-called convenience panels, which only include participants who are already online, and who volunteer through word-of-mouth or advertising to participate in surveys.

The margin of error for the full sample is +/- 3.5% and the completion rate for the survey was 48% (the completion rate refers to the number of panelists who completed the survey out of the total who were invited to participate). Unless otherwise noted, all findings refer to the full sample of 13- to 18-year-old respondents. Where relevant, findings are broken out by age, gender, race/ethnicity, and socio-economic status. Low-income families are those with annual income of less than \$25,000; middle-income is \$25,000–75,000 a year; and high income is over \$75,000 a year. Percentages may not total 100% due to rounding, the omission of "refused" or "don't know" responses, or because multiple responses were allowed.

## 2.2. Demographic and Health-Related Variables

Panelist data on yearly household income was provided by GfK. Low-income families are those with annual income of less than \$25,000; middle-income is \$25,000–75,000 a year; and high income is over \$75,000 a year.

Activity level was assessed by asking participants, “In the past 30 days, how often have you participated in physical activities, such as playing sports, running, working out, taking a dance class, or doing yoga?” Participants were asked to select from “often,” “sometimes,” “only once or twice” or “never.”

Participant body mass index (BMI) was assessed using self-reported height (in inches) and weight (in pounds). Finally, general level of health was assessed through the question “In general, how is your health?” Participants were asked to select “excellent,” “good,” “fair,” or “poor.”

## 2.3. Sources of Health Information

Participants were asked how much health information they had received from the following sources: parents, health classes, doctors/nurses, the Internet, social networking sites, friends, siblings, ads, TV news, other TV shows, newspaper articles, magazine articles, radio and books. Responses ranged from “a lot,” “some,” “only a little” to “none.” This question was used to determine top sources of health information as well as how much teens used the Internet and social networking for health information.

Use of specific online sources was assessed by asking participants whether they had used “any of the following for information, advice or tools on a health topic: Google, YouTube, Wikipedia, Twitter, Yahoo, Facebook, any other social networking site, a website specifically for teens, a medical website, your doctors web site, an online support group or community, online tools to track your health, and blog posts about a health topic.”

Usage of mobile apps for health information was assessed through the question “How often do you use a health-related mobile app?” Responses ranged from “often,” “sometimes,” “hardly ever,” to “never.”

## 2.4. Health Behavior Change

To assess whether digital technology had aided teens in changing their behavior, participants were asked, “Have you ever changed your behavior because of health related information online?” Participants were also asked if they had ever changed their behavior because of any of the health-related mobile apps they used. Additionally, participants were queried regarding whether they had changed their weight, fitness routine or diet or nutrition due to online information or mobile apps.

## 3. Results

### 3.1. Digital Platforms Used for Health-Information Seeking

#### 3.1.1. Internet

A total of 84% of teens reported having received health information online during their lifetime, including a quarter of all teens (25%) who said they have received “a lot” of health information online, 36% who get “some” and 22% who get “only a little” health information online. The 25% of teens who get a lot of health information online is less than half the proportion that gets a lot of information from their parents (55%), but it is surprisingly close to the proportion that gets “a lot” of health information from doctors and nurses (29%). And the Internet far outstrips other “traditional” media as a source of health information for teens: only 10% said they get a lot of information from books, 9% from TV news, and 3% from newspaper.

Nevertheless, parents remain the most frequently turned to source of health information, with 55% of teens reporting that they get “a lot” and 33% reporting that they get “some” health information from their parents. Furthermore, 29% teens also reported getting “a lot” and 40% reported getting “some” health information from doctors and nurses.

Looking for health information online is not a very frequent activity for most youth. About a quarter (24%) of teens sought health information online at least monthly or more often. The largest group of teens (38%) said they go online for health information only a few times a year. Another quarter do so less often than a few times a year, while 16% never look for health information on the Internet.

Additionally, a multiple regression analysis was conducted to determine which demographic and health-related variables predicted use of the Internet for health information-seeking ( $R = .26$ ,  $R^2 = .07$ ,  $F(10, 1072) = 8.78$ ,  $p = .000$ ). Age, race, income, physical activity level and general health significantly predicted use the Internet for health. Older ( $\beta = .05$ ,  $p < .05$ ), wealthier ( $\beta = .02$ ,  $p < .01$ ), more active ( $\beta = .16$ ,  $p = .000$ ) and healthier ( $\beta = .21$ ,  $p = .000$ ) teens reported using the Internet for health more frequently. African-American ( $\beta = .50$ ,  $p = .000$ ) and Hispanic ( $\beta = .20$ ,  $p < .05$ ) teens reported using the Internet for health to a greater extent than their white counterparts (see Table 1).

#### 3.1.2. Social Networking Sites

Most teens do not turn to social networking sites for health information, but some do. One in ten teens (10%) said they get “a lot” of health information from social networking sites, and an additional 23% said they get at least “some” from such sites.

**Table 1.** Predictors of digital platform use for health-information seeking.

| Digital Platform                                             | Internet |              |             | Social Networks |              |             | Mobile Apps |              |             |
|--------------------------------------------------------------|----------|--------------|-------------|-----------------|--------------|-------------|-------------|--------------|-------------|
|                                                              | $\beta$  | <i>T</i>     | <i>Sig.</i> | $\beta$         | <i>T</i>     | <i>Sig.</i> | $\beta$     | <i>T</i>     | <i>Sig.</i> |
| Age                                                          | .08      | 2.55         | .011        | .07             | 2.20         | .028        | -.06        | -.98         | .329        |
| Gender                                                       | .01      | .34          | .732        | .09             | 3.17         | .002        | .21         | 3.31         | .001        |
| Race                                                         |          |              |             |                 |              |             |             |              |             |
| Black                                                        | .15      | 4.63         | .000        | .13             | 4.07         | .000        | .01         | .16          | .874        |
| Hispanic                                                     | .07      | 2.37         | .018        | .08             | 2.44         | .015        | -.01        | -.02         | .938        |
| Multiracial                                                  | .03      | .85          | .394        | .06             | 1.84         | .066        | -.03        | -.40         | .683        |
| Other                                                        | -.05     | -1.74        | .081        | -.06            | -1.99        | .047        | .02         | .31          | .760        |
| Income                                                       | .09      | 2.87         | .004        | .02             | .56          | .576        | -.01        | -.15         | .881        |
| Physical Activity Level                                      | .17      | 5.40         | .000        | .14             | 4.47         | .000        | .10         | 1.52         | .130        |
| General Health                                               | .11      | 3.84         | .000        | .12             | 3.91         | .000        | -.02        | -.25         | .802        |
| BMI                                                          | .05      | 1.67         | .092        | .01             | .13          | .896        | -.17        | -2.50        | .013        |
| <i>Model Summary: R<sup>2</sup> (Adjusted R<sup>2</sup>)</i> |          | .08<br>(.07) |             |                 | .08<br>(.06) |             |             | .09<br>(.04) |             |

A multiple regression analysis was performed to determine demographic and health-related predictors of social network use for health ( $R = .26$ ,  $R^2 = .07$ ,  $F(10, 1072) = 7.81$ ,  $p = .000$ ). Age, gender, race, physical activity level and general health were significant predictors of how much information teens reported getting from social networking sites. Teens who were older ( $\beta = .04$ ,  $p < .05$ ), female ( $\beta = .21$ ,  $p < .01$ ), more active ( $\beta = .13$ ,  $p = .000$ ) and in better health ( $\beta = .20$ ,  $p = .000$ ) were more likely to use social networking sites for health information. African-American ( $\beta = .42$ ,  $p = .000$ ) and Hispanic ( $\beta = .20$ ,  $p < .05$ ) teens reported using social networking sites for health more than their white counterparts. Conversely, teens in the “other” race category ( $\beta = -.29$ ,  $p < .05$ ) reported using social networking sites for health less frequently than white teens (see Table 1).

### 3.1.3. Mobile Health Applications

Among all 13- to 18-year-olds, 62% reported having a smartphone, 51% having a laptop, and 37% having their own tablet device. A total of nearly three-quarters (73%) had either a tablet or smartphone, which would allow them to download and use mobile health apps, while 27% had neither mobile option, and thus were unable to use such apps on a regular basis. Among teens with a mobile device, 29% had downloaded a health-related app (21% of all teens). Fitness and nutrition-related apps were by far the most common among the topics asked about in this survey. Nearly a quarter (23%) of teens with mobile access had downloaded an app related to exercise or fitness, while 14% had downloaded a calorie-counter or other nutritional app. Although 21% of all teens had downloaded a health-related mobile app, far fewer actually used them. Among those who had downloaded a health-related app, almost half (47%) hardly ever or never

used them, another 45% sometimes used them, and 8% often used them. (Among all teens, 10% hardly ever or never used their health-related mobile apps, 10% sometimes used them, and 2% often used them.)

A multiple regression analysis was conducted to determine which demographic and health-related variables predicted frequency of health app use ( $R = .30$ ,  $R^2 = .09$ ,  $F(10, 232) = 2.22$ ,  $p = .02$ ). Gender and BMI were significant predictors of health-related app usage. Females ( $\beta = .37$ ,  $p < .01$ ) and teens with a lower BMI ( $\beta = -.02$ ,  $p < .05$ ) reported using health-related mobile apps more frequently (see Table 1).

### 3.1.4. Wearable Health Devices

The vast majority of teens (91%) had never used a wearable health tracker such as a Fitbit or Fuel Band. Indeed, the conversation in focus groups indicated that many teens consider such devices an “adult” thing. According to the survey, only 2% of teens were current users of such devices, while 5% said they’ve used one in the past. The sample size of wearable device users was too small for further analysis.

### 3.2. Health Topics Researched Online

Among the topics asked about in this survey, fitness and nutrition were by far the most likely topics for teens to have researched online. Among all teens, 42% had looked for information on fitness and exercise online, and 36% had done the same for information about diet and nutrition (see Table 2).

Clearly, the Internet has become a key resource for young people concerned about eating well and exercising. Stress and anxiety seem to be other key concerns for teens, with 19% having looked for information about these topics online—the third most-common topic researched online (among those we asked about).

**Table 2.** Differences in health concerns and ownership of digital devices by family income.

| Among 13 to 18 year olds, % who...                                                       | Among all | Low-income<br>(<\$25k per year) | Middle-income<br>(\$25-\$75k per year) | High-income<br>(>\$75k per year) |
|------------------------------------------------------------------------------------------|-----------|---------------------------------|----------------------------------------|----------------------------------|
| <i>Have a family member who has faced a significant medical problem in the past year</i> | 35        | 52                              | 39                                     | 27                               |
| <i>Say each issue is "very" important to them personally</i>                             |           |                                 |                                        |                                  |
| ADHD                                                                                     | 19        | 27                              | 24                                     | 12                               |
| Cancer                                                                                   | 24        | 40                              | 28                                     | 17                               |
| Colds/flu                                                                                | 17        | 28                              | 21                                     | 10                               |
| Dental health                                                                            | 36        | 48                              | 39                                     | 29                               |
| Depression/mental illness                                                                | 28        | 44                              | 31                                     | 21                               |
| Diabetes                                                                                 | 21        | 38                              | 24                                     | 12                               |
| Domestic violence/sexual assault                                                         | 30        | 45                              | 33                                     | 22                               |
| Drug/alcohol abuse                                                                       | 32        | 43                              | 37                                     | 24                               |
| Eating disorders                                                                         | 22        | 31                              | 27                                     | 14                               |
| Heart disease                                                                            | 19        | 32                              | 24                                     | 11                               |
| Pregnancy                                                                                | 27        | 34                              | 33                                     | 19                               |
| Smoking                                                                                  | 27        | 37                              | 33                                     | 19                               |
| <i>Have their own:</i>                                                                   |           |                                 |                                        |                                  |
| Laptop                                                                                   | 51        | 32                              | 50                                     | 58                               |
| Tablet                                                                                   | 37        | 26                              | 38                                     | 42                               |
| Smartphone                                                                               | 62        | 44                              | 60                                     | 69                               |

Other top-ten topics researched online include sexually transmitted diseases (STDs) (18%), puberty (18%), sleep (16%), depression or other mental health issues (16%), hygiene (12%), colds/flu (12%), and drug or alcohol abuse (12%).

Girls were more likely than boys to have looked up certain topics online: for example, depression (22% of girls, compared to 10% of boys), diet/nutrition (44% of girls vs. 29% of boys), stress/anxiety (25% vs. 14%), and eating disorders (17% vs. 5%).

### 3.3. Sources of Health Information Online

Many teens use search engines such as Google to direct them to health information (49%) or visit medical websites (31%). But some teens use less traditional types of online platforms to get health information. For example, one in five (20%) had gotten health information from YouTube, 9% from Facebook, and 4% from Twitter. Among those who search for health information online, younger teens (13- to 15-year-olds) were more likely than older ones to have gotten health information from YouTube (28% vs. 21%) and to have visited a website specifically for teens (12% vs. 7% of older teens); Hispanic youth were more likely than others to have used Yahoo to search for health information (23% vs. 10% of White and 8% of Black youth); and girls were more likely than boys to go to medical websites (42% vs. 32%).

#### 3.3.1. Search Methods

Among the 84% of teens who had used the Internet for

health information (online health-seekers), 58% said they "often" start their searches by Googling a topic. Far fewer use other search engines this often (14%) or go directly to a site they are familiar with (23%). Some teens simply come across health information online, while browsing (9% say this often happens), through links on social network sites (6%), or because of seeing something in an ad (3%).

Once teens have Googled a health topic, half (50%) said they usually click on the first site and only go further if they still have questions after reading the information on that site. A slightly smaller proportion (44%) said they generally check several sites so they can compare the information they're getting. Black (20%) and Hispanic (22%) youth were more likely than White youth (10%) to say they often look for health information online by using search engines other than Google.

### 3.4. Digital Health Information and Behavior Change

Among those who have looked for health information online (84% of all teens), 34% said they have changed their behavior because of what they found. Among those who have used a mobile health app (21% of all teens), 36% said they changed their behavior because of the app. And among those who used a wearable digital health device (7% of all teens), 17% said they changed their behavior because of it. From the base of "all teens," this means that 28% say they have changed a health-related behavior due to online information, 7% due to a mobile app, 2% due to digital games, and 1% due to wearable devices.

Many teens use the Internet and digital health tools to advance their fitness and nutrition. Because of national concern with obesity, the survey asked specifically whether teens had changed their fitness routines or diets due to online health information or digital health tools, and also asked whether their weight had changed as a result. Among the base of all teens, 18% reported having changed their diet or nutrition due to online health information, and 15% reported having changed their fitness routine; 8% said their weight had also changed. Among all teens, 5% reported having changed their diet/nutrition due to a mobile app, and the same percent reported changing their fitness routine; 3% reported a change in their weight.

In trying to explore whether some youth are more likely than others to change a health behavior in response to online information, the survey data on this issue were analyzed by age, gender, family income, and race/ethnicity. No differences were located by age, gender or family income. However, Black or Hispanic teens were more likely than other teens to report having changed a health behavior in response to online health information, with 40% of Black and 42% of Hispanic teens who get health information online reporting a behavior change in response to it, compared with 29% of White youth.

### 3.5. Adolescents and the Digital Divide

The survey indicates there is still a substantial divide in personal ownership of digital devices. Data were analyzed by family income, parent education, and race/ethnicity. The largest and most consistent differences in digital device ownership occurred by income. There was no significant difference in the percent of teens who had their own desktop computer (24% among all), but there were substantial differences in the percent who have their own tablet (a 17% age point gap by income), laptop, or smartphone (25% age point gaps) (see Table 2).

The most widely available mobile digital device was the smartphone, which 62% of all 13- to 18-year-olds had. However, access varies substantially, from 44% of low-income to 69% of higher-income teens. Half of all teens (51%) reported having their own laptop, but again, this varied from 32% of low-income youth to 58% of higher-income teens. Overall, 37% of teens reported having their own tablet device, ranging from 26% of low-income teens to 42% of higher income ones (see Table 2).

Concern over various health topics also varies by income level. Teens from lower income levels tended to have greater concern over health topics such as ADHD, depression/mental health, heart disease and pregnancy. As income increased, concern for such topics tended to decrease. Overall, low-income teens were more likely to report that a family member had a significant

health problem in the past year (see Table 2).

## 4. Discussion

In this study, we sought to understand how teens are using the Internet, mobile apps and wearable health technology as sources of health information. Despite the fact that the Internet offers adolescents anonymous access to an abundance of information on virtually any health topic they could think off, it is perhaps heartening that young people still primarily rely on interpersonal sources of health information, such as their parents, doctors or nurses. This may indicate that the Internet is not replacing interpersonal sources, but rather, supplementing them. This result confirms previous findings that teens are more comfortable seeking out health information from interpersonal sources, especially for sensitive health topics (Gray et al., 2005; Jones & Biddlecom, 2011).

Despite the importance of interpersonal sources of health information, the vast majority of teens—84%—also turn to the Internet for health information, and one in four say they get “a lot” of their health information online. The Internet has far eclipsed other media as a source of health information and has empowered young people to arm themselves with information and tools to address their own health concerns and to help those around them.

In essence, the study indicates that when it comes to teens and health information, the Internet is essentially functioning the way one would hope it would. Young people are using online health information to help them eat healthier, sleep better, cope with stress, and stay fit. When they have everyday health issues such as colds or sprains, they use the Internet for advice or to prepare for or follow-up on doctor’s visits. When they face more serious challenges such as depression, attention deficit disorder, or self-harm, they are looking for and using tools to care for themselves. And when family members face significant problems such as diabetes, cancer, or Alzheimer’s, teens are using the Internet to learn more and find out how they can help.

A key goal of this study was to explain which health topics teens search online. As prior studies indicated, adolescents are concerned with a myriad of health topics, ranging from mental health to physical health (Skinner et al., 2003). Teens seem particularly concerned with diet and fitness, with these topics far outpacing the others. Far more adolescents reported searching for these topics than those who reported searching for more sensitive health topics (e.g. sexual health, depression and anxiety). This confirms previous findings that teens may be wary of searching for sensitive health topics online (Gray et al., 2005; Jones & Biddlecom, 2011; Lenhart, 2010). Nevertheless, our findings indicate that topics such as mental health are of importance to a substantial percentage of adoles-

cents, and adolescents are willing to seek information about these topics online. Thus, this highlights the importance of ensuring that teens are able to find accurate information about sensitive and serious health topics online.

When it comes to adolescents' use of social networking sites for health, results indicate that teens still tend to be wary of posting health-related questions or viewing health related information on social media. While the Internet may afford teens some semblance of anonymity, the case may not always be the same for social media. This finding confirms past research which indicates that teens may be wary of discussing health topics, especially those of a sensitive nature, when their names can be associated with such information (Divecha et al., 2012). This finding may indicate that social media may not be the best outlet for attempting to reach adolescents with health information.

This study also sought to understand how teens use the newest sources of health information—apps and wearable devices. As the number of mobile apps for health steadily grows, adolescents seem to slowly increase usage of such sources of information. However, the Internet still outpaces mobile health apps as sources of information. Furthermore, most teens report downloading apps, yet rarely or never using them. This may indicate that apps do not always hold the attention of teens past initial use. Future research should examine the mechanisms of mobile apps for health that would elicit consistent use from teens. Adolescent use of wearable devices is still very low, potentially indicating that teens see such devices as not for their age group.

Our analysis also revealed key demographic and health-related differences among the use of digital devices for health. Teens who were older, healthier and more active reported using the Internet more for health purposes. Similarly, teens who were older, healthier, and more active also used social networking for health more often. Additionally, girls tended to use social networking for health more than boys. Explanations for this may include that teens who are older are more accustomed to Internet use than their younger peers, and thus, may seek health information more frequently. Teens who are older may also face more health challenges and questions than younger teens, such as questions that surround sexual activity. Furthermore, teens who are in good health and pursue active lifestyles may be primed to search for information which allows them to stay active, fit and in good health. This may also explain why teens who were more active and had a lower BMI tended to use health-related mobile apps more frequently. This comes as little of a surprise as one of the most frequently downloaded types of apps among teens were fitness apps.

Our analysis also revealed racial differences regarding use of the Internet and social media for health. Af-

rican-American and Hispanic teens were more likely than their white counterparts to use these platforms for health information (although teens in the "other" category were less likely than white teens to use social networking for health). This may indicate that some non-white teens may be relying on digital health information more so than their white peers. Future studies should examine the cultural and socio-economic factors that may contribute to this reliance.

Such racial-ethnic differences were not observed for mobile applications. Mobile applications for health, while pervasive, are still a relatively new technology. Thus, although a sizable portion of teens report using them, the Internet and social media far outpace in terms of teen use. Despite their novelty, access to such mobile technology is becoming more equal between racial-ethnic groups (Lenhart, 2015). It also appears that the use and application of such technology for health is also becoming more equal among teens. Implications of this finding are that scholars and interventionists may consider use of the Internet and social media to reach teens and that mobile applications may be used to reach a more diverse sample of teens.

Our next research question queried how adolescents use the Internet to search for health information—the online sources most frequently used and the ways that teens navigated these sources. Google emerged as a top source that adolescents gravitate toward when searching for health information online, far above other search engines and social media sources (e.g. Youtube and Twitter). While the majority of teens tended to use Google, Black and Hispanic teens were far more likely to use search engines other than Google. Future research should examine why minority teens tend to use these sources.

Teens also reported that they start their searches with Google, similar to previous studies (Gray et al., 2005). Also similar to past research (Hansen et al., 2003), participants indicated that they often selected the first search result in Google, without searching further. This may indicate that when teens search for information, their searches may be more cursory and quick, without the use of in-depth search tactics. On the other hand, a sizeable percentage of teens reported cross-checking information with other sources, which may indicate a higher level of digital literacy. Future research should examine under which circumstances and which demographic and educational variables correlate with cursory or extended health information seeking online. These findings also highlight the need to ensure that information available online is accurate and helpful to adolescents, as they may not know how to properly search for the best health resources.

Our subsequent research question sought to examine the potential of existing online and mobile health information in eliciting health behavior change among



adolescents. Prior research has indicated that the Internet and mobile devices can operate as very successful platforms for staging health behavior interventions with adolescents (Crutzen et al., 2010). However, this study was the first of its kind to examine health behavior relating to existing Internet-based health information, using a nationally representative sample. Of those who had used the Internet to search for health information, about one third reported changing their health behavior due to the information they found. Similarly, about a third of those who had downloaded a mobile app reported changing their behavior due to the app. These findings indicate the potential of digital health information to change adolescent health behavior. In addition, a greater percentage of Black and Hispanic teens reported that online information had changed their behavior. This may indicate that online platforms may be uniquely positioned to reach this demographic. Overall, our findings indicate that the digital health information that adolescents frequently access may have the power to influence their health behaviors.

Our fifth and final area of interest concerned how the digital divide impacts adolescents. While there appears to be greater equality in access to desktop computers, our findings indicate that there is still a gap in access to laptop computers, smartphones and tablets. This corroborates previous research, which showed that, although gaps have been closing, there still remains inequality in access to digital technology and information (Lenhart, 2012; Peter & Valkenberg, 2006). Our findings also indicated that, across a range of different health topics, lower income teens tend to have more concern over health issues than their higher income peers. This is the case for many highly sensitive health topics (e.g. depression, domestic violence/sexual assault, drug/alcohol abuse, eating disorders and pregnancy). Lower income teens also reported greater instances of family health problems than their higher income peers. As the digital divide continues to disadvantage lower income youth, these findings are of particular concern. While lower income teens may have greater concern over potential and existing health problems, they may have less access to the information that may help ease their worries, provide education or even change their behavior.

## 5. Conclusion

This study was not without limitations. First, this study relied on self-report. As adolescents may not accurately remember their exact digital search behaviors, the information they viewed and the impact this information had on their health behaviors, future research is still necessary. In the future, scholars should examine the impact of specific sources of health information on adolescent health knowledge and behavior.

While participants in this study indicated whether digital information helped change their health behaviors, there is no record of what these specific behaviors were (e.g. how teens changed their weight) or whether these behaviors were healthy or unhealthy. Future research should examine the specific types of health behaviors that digital health information changes and whether these changes positively or negatively impact the health and well-being of adolescents.

In the age of digital media, teens are virtually tethered to technology and digital devices. As access to digital information has increased, teens are able to reach health information with a click of a mouse or tap on a smartphone. Although teens still heavily rely on people above technology when it comes to health information, they also use digital technology to a great extent. Thus study underscores the importance of making sure there is accurate, appropriate and easily accessible health information available to teens online. As teens use and act upon this information, it is crucial that what they are viewing will improve their health and well-being. Furthermore, this study highlights the importance of educating teens to properly navigate the ever-increasing digital library of health information, as well as how to search for answers to health questions without merely relying on the first result they find. Finally, this study indicates that the digital divide still impacts teens in the United States—greater effort to bridge these gaps may have influence on their health information-seeking and health behavior. Although digital health information is clearly not a panacea, adolescent use of digital tools to better understand their health may allow today's youth to have greater autonomy in regards to their health and allow them to pursue healthier choices.

## Conflict of Interests

The authors declare no conflict of interests.

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