Health Communication
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t775653649

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Online Publication Date: 01 September 2008

To cite this Article Shim, Minsun(2008)'Connecting Internet Use with Gaps in Cancer Knowledge',Health Communication,23:5,448 — 461
To link to this Article: DOI: 10.1080/10410230802342143
URL: http://dx.doi.org/10.1080/10410230802342143

Health Communication, 23: 448–461, 2008

ISSN: 1041-0236 print / 1532-7027 online
DOI: 10.1080/10410230802342143

Routledge
Taylor & Francis Group

Connecting Internet Use with Gaps in Cancer Knowledge

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This study applies the knowledge gap hypothesis to the specific domain of Internet use for cancer information. In particular, this study examines disparities in online information seeking by education and ethnicity, and subsequent gaps in cancer knowledge. Perceived risk of cancer and ease of connection to the Internet are concerned as contingent factors influencing knowledge gaps. A subsample of the 2003 Health Information National Trends Survey—those who have ever been online—was analyzed. Data supported the hypothesis that high education groups and White Americans were more likely to use the Internet for cancer information than were their counterparts, and online information seeking enlarged to some degree the cancer knowledge gaps between education groups. Perceived cancer risk had a weak but significant three-way interaction effect with ethnicity and online seeking on cancer knowledge, which suggests the importance of motivation in attenuating the knowledge gaps. The moderating role of ease of connection to the Internet was not supported. Discussion about the findings and further suggestions are offered.

There has recently been a dramatic expansion in health information resources available online (Cline & Haynes, 2001; Rice & Katz, 2001; Viswanath, 2005). Although such expansion increases the possibility that individuals will seek and obtain a variety of health information on the Internet beyond what they would get from health care providers, traditional mass media, and interpersonal communication sources (Brashers, Goldsmith, & Hsieh, 2002; Dutta-Bergman, 2005; Fox et al., 2000), it might not benefit all segments of the society equally. Indeed, disparities in online health information seeking by socio-economic status (SES) and race/ethnicity are found among the general population (Bolt & Crawford, 2000) and in those living with specific diseases (Kalichman et al., 2002; Satterlund, McCaul, & Sandgren, 2003).

One of the particular health concerns for which this issue is most prominent is cancer. As one explanation of the reasons behind the complicated, strong relationships of cancer incidence and mortality with SES and ethnicity (National Cancer Institute, 2005; Ward et al., 2004), Viswanath (2005) points out unequal access to cancer information among different social groups. According to the knowledge gap hypothesis (Donohue, Tichenor, & Olien, 1975; Tichenor, Donohue, & Olien, 1970), different social groups tend to gain unequal levels of health knowledge under conditions of increasing information flow (Viswanath et al., 2006), such as the extensive availability of cancer information online. Because a significant portion of deaths from cancer are attributed to modifiable risk factors, for example, tobacco use and physical inactivity (Stein & Colditz, 2004), learning from information available through the media will play an important role in cancer prevention and detection, especially in high-risk groups (Viswanath, 2005).

Despite its practical and theoretical implications, Internet use for cancer information among different social segments has not been adequately studied. This study applies the knowledge gap hypothesis to cancer communication within the digital divide framework, and analyzes national survey data collected by National Cancer Institute. Three issues are addressed. First, the focus of the literature on health knowledge gaps is expanded beyond education to include racial/ethnic disparities. Second, this study examines inequalities in Internet use for cancer information, with additional concerns about potential contingent factors (perceived risk of cancer and ease of connection to the Internet). Last, a consequence of these usage gaps is studied

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as multivariate phenomena, that is, the relative size of cancer knowledge gaps among different social groups at different levels of Internet usage and contingent factors.

THE KNOWLEDGE GAP HYPOTHESIS IN HEALTH COMMUNICATION RESEARCH

The knowledge gap hypothesis posits, "As the infusion of mass media information into a social system increases, segments of population with higher socio-economic status tend to acquire the information at a faster rate than the lower status segments," and therefore "the gap between these segments tends to increase rather than decrease" (Tichenor, Donohue, & Olien, 1970, pp. 159–160). Tichenor et al. discuss several factors to explain the observed phenomenon of widening gap, such as differences between those of higher and lower SES in communication skills, prior knowledge or stored information, relevant social contacts, and so on (for further discussions, see Bonfadelli, 2002; Eveland & Scheufele, 2000).

Health knowledge, which is a topic of universal appeal, has attracted great research attention (Viswanath & Finnegan, 1996). The initial article on the knowledge gap hypothesis (Tichenor et al., 1970) included the association between smoking and lung cancer as one of the three topics to test the hypothesis with time trend data. As a predictor of health knowledge gaps, SES has been typically operationalized as education, and a variety of health issues have been concerned, including cancer (Yows, Salmon, Hawkins, & Love, 1991), cardiovascular disease (Ettema, Brown, & Luepker, 1983; Viswanath, Kahn, Finnegan, Hannan, & Luepker, 1991), and AIDS (Salmon, Wooten, Gentry, Cole, & Kroger, 1996).

However, the observed findings are not as simple as the prediction of the initial knowledge gap hypothesis (Gaziano, 1983, 1997; Viswanath & Finnegan, 1996). Among the reviewed studies particularly concerning health issues (Gaziano, 1997, pp. 243–244), five studies found the expected knowledge gap by media publicity or exposure at one point in time, whereas two did not. Findings about the over-time change in knowledge gaps by media publicity or exposure ranged from an increase in the gap, to no change, to a decrease in the gap, as well as mixed patterns of the gap observed within a study (Gaziano, 1997).

To explain these diverse findings, researchers have examined a variety of contingent conditions of the knowledge gap. Important among them are the form and structure of different media channels, saturation of media coverage, complexity of knowledge, the size and complexity of the community, and individuals' motivation and ability (Donohue, Tichenor, & Olien, 1975; Ettema & Kline, 1977; Kwak, 1999; Rucinski, 2004; Viswanath & Finnegan, 1996; Viswanath et al., 2006). In particular, concerns about individuals' motivations and ability have led to development of three different models (Bonfadelli, 2002). The model developed by proponents of the initial hypothesis posits that motivational factors mediate the effects of SES on knowledge gaps, whereas an alternative model regards SES and motivational factors as independent and competing causes of knowledge gaps; and a third model posits that SES and motivational factors have joint effects on knowledge gaps (Kwak, 1999).

THE KNOWLEDGE GAP HYPOTHESIS APPLIED TO THE INTERNET

The first thing to do when applying the knowledge gap hypothesis to a new media channel (e.g., the Internet) is to consider the distinctive form and structure of this channel compared to traditional mass media (e.g., television and newspapers). Bonfadelli (2002) discusses the differences between them in the emergence of knowledge gaps from four aspects: information supply, audience access to information, individual motivation and ability, and knowledge acquisition. Compared to traditional mass media, the Internet offers potentially unlimited heterogeneous information, but access to the Internet itself is rather restricted and its usage is more dependent on individuals' motivation and skills; as a result of these "gaps in access, use, and skills," knowledge gaps may occur (Bonfadelli, 2002, p. 73).

Gaps in Access to the Internet

The Internet provides rather restricted access to people, depending on their income, education, ethnicity, age, and geography (National Telecommunication and Information Administration, 1995, 1999, 2000), whereas the overall level of access to traditional mass media is high. The term *digital divide* originally referred to the inequalities between those who are connected and those who are disconnected from the information and communication technology (Selwyn, 2004).

Much of the early research that applied the knowledge gap perspective to the Internet focused on unequal access to this new medium between social groups (Katz & Rice, 2002; see e.g., Bonfadelli, 2002; Hoffman & Novak, 1998; Nie & Erbing, 2000). Access to the Internet in Switzerland, for instance, was dominated by highly educated and affluent people, and from 1997 to 2000 the gap between those with access and those without had widened, not narrowed (Bonfadelli, 2002). In addition, in other countries, Internet access has been patterned along the lines of gender (with higher proportions of males than females having access to the Internet), age (as inversely associated with Internet access), and geography (with more economically prosperous regions having higher levels of Internet access; Selwyn, 2004), as well as ethnicity (with more White Americans than African Americans having access; Hoffman & Novak, 1998).

Gaps in Use of the Internet

With some studies reporting that the digital divide of unequal access is closing (e.g., Katz, Rice, & Aspden, 2001), many researchers claim that it is important to consider not only gaps in access to the Internet but also gaps in use of the Internet (e.g., Bonfadelli, 2002; DiMaggio, Hargittai, Celeste, & Shafer, 2004; Gunkel, 2003; Katz & Rice, 2002; Selwyn, 2004; Van Dijk & Hacker, 2003), which is called the *usage gap* by Van Dijk (1999).

Cho, Zuniga, Rojas, and Shah (2003) found differences in the ways the Internet was used across subgroups divided by SES and age, as well as the gratifications gained from their Internet use. Respondents who were young and high in SES were more likely to use the Internet in a strategic way to satisfy their motivations and achieve the desired gratifications of social connection, learning, and personal acquisition. Young respondents with low SES, by contrast, were more likely to engage in consumptive use of the Internet (e.g., product purchase). Similar findings were offered by Bonfadelli (2002) such that the better educated used the Internet for informational purposes, whereas the less educated were more likely to seek out entertainment.

Gaps in Skills Using the Internet

The problems of structurally different skills and usage of the Internet may become more significant as the problems of material and mental access are resolved (Van Dijk, 1999). Selwyn (2004) argues against the determinist belief that access to the Internet inevitably leads to use of it, and emphasizes the importance of seeing how individuals are actually able to take advantage of Internet access. The definition of digital skills should not be limited to one's ability to operate computers and the Internet; rather, it needs to include the ability to search, select, process, and further apply information from a number of sources available online (Van Dijk & Hacker, 2003).

Bonfadelli (2002) found gaps in self-rated computer skills between different education groups such that 43% of Internet users with low education rated their skills as beginner-level, whereas only 15% of highly educated Internet users thought so. Hargittai (2002, 2004) named this phenomenon as *a second-level digital divide* and examined how successfully and quickly people were able to find information about various topics on the Internet in a controlled setting. Those with a graduate degree exhibited a greater success rate in task completion and spent less time on information seeking compared to college graduates and the less educated. In contrast, Van Dijk & Hacker (2003) found that computer and online information–seeking skills were primarily associated with age and gender, not with education levels.

Gaps in Knowledge

Despite his thorough theoretical explanation that gaps in Internet access, use, and skills may lead to gaps in knowledge, Bonfadelli (2002) did not present empirical evidence to support this explanation. Data in the article support gaps in access to, use of, and skills with the Internet that are mainly based on education levels; however, no empirical evidence on knowledge gaps as an outcome is reported. In fact, a lack of research on potential outcomes of unequal Internet use among different social segments is found with the broader digital divide framework (Selwyn, 2004). Research is beginning to examine gaps beyond simple access or usage, for example, DiMaggio et al.'s (2004) theoretical work on the impact of Internet use on social and human capital and Shah, Kwak, and Holbert's (2001) empirical study connecting the patterns of Internet use with the production of social capital.

CONNECTING INTERNET USE WITH GAPS IN KNOWLEDGE ABOUT CANCER

For the purpose of applying the knowledge gap hypothesis to the specific domain of Internet use for cancer information, this study addresses three issues. First, the focus of the literature on health knowledge gaps is expanded beyond education to include ethnic disparities. Second, concerning gaps in cancer information seeking as one type of Internet use, this study also considers possible contingent conditions. Third, gaps in Internet use are linked to a potential outcome, that is, gaps in cancer knowledge.

Race/Ethnicity and Cancer Disparities

Race/ethnicity has gained less attention than education in research on health knowledge gaps (for examples concerning ethnicity, see Alcalay & Bell, 1996; Pratt, Ha, Levine, & Pratt, 2003, Rucinski, 2004; Viswanath et al., 2006). It may be because ethnicity was not proposed as a main predictor by the initial knowledge gap hypothesis. However, not only education but also ethnicity is strongly associated with health disparities, and ethnicity matters even after education is controlled for (Stewart & Napoles-Springer, 2003). With regard to cancer, African and Hispanic Americans are less likely to get screened than are White Americans (Lees, Wortley, & Coughlin, 2005). African American men present higher incidence rates of developing any type of cancer than do White men in the United States; African American women, despite their lower rate of incidence of breast cancer, are more likely to die from it than White women (National Cancer Institute, 2005). In lower education groups, risk factors of cancer such as tobacco use and obesity are more prevalent than in higher education groups; however, those with lower SES are less likely to engage in

protective behaviors like regular screening (Breen et al., 2005) and have higher cancer mortality rates (National Cancer Institute, 2005; Ward et al., 2004).To account for these differential health behaviors and cancer disparities by looking at gaps in access to information between different social segments (Viswanath et al., 2006), we need to regard race/ethnicity as well as education levels as primary predictors of cancer knowledge gaps.

Gaps in Seeking Cancer Information on the Internet

Internet use for health information is becoming more common. In a survey of self-reported online users age 21 or over in the United States, approximately 40% of the sample reported they had ever used the Internet for health information or advice during the past year, and about one third of them said the information they found affected their decision making (Baker, Wagner, Singer, & Bundorf, 2003). According to Satterlund et al.'s (2003) summary review, previous studies have reported that anywhere from 36% to 55% of online users in the U.S. population have used the Internet to seek medical or health-related information, and cancer is one of the top two diseases about which people seek information on the Internet.

The problem is that online health information seeking is associated with individuals' education, ethnicity, or other demographic factors. That is, those who are less educated, less affluent, and socially disadvantaged are less likely to use health information on the Internet than are their counterparts (Bolt & Crawford, 2000). This inequality in Internet use is also found among people living with specific diseases (Fogel, Albert, Schnabel, Ditkoff, & Neugut, 2002; Kalichman et al., 2002). For example, breast cancer patients who used the Internet for medical information more frequently were found to have higher education, earn greater income, and be younger than patients with less frequent use (Fogel et al., 2002).

Although cancer information seeking, such as searching the Internet or calling the Cancer Information Service (Czaja, Manfredi, & Price, 2003; Muha, Smith, Baum, Ter Maat, & Ward, 1998), has been studied extensively, most research has focused on cancer patients in terms of their information needs (Lock & Willson, 2002; Rees, Sheard, & Echlin, 2003), the quality of information received (Kunst, 2002; Mills & Davidson, 2002), and preferences for different media sources (James, James, Davies, Harvey, & Tweddle, 1999; Mills & Davidson, 2002). There has not been sufficient research on usage gaps in seeking cancer information on the Internet, especially among the general population. Seeking cancer information online to stay informed may be relevant to most people because cancer is the second leading cause of deaths in the United States, contributing to nearly 23% of deaths in 2002 (American Cancer Society, 2005), and new treatment options as well as links to lifestyle behaviors are emerging frequently.

Based on this reasoning, this study poses the following hypotheses concerning disparities between different segments of general population in Internet use to learn specifically about cancer. The focuses in this study are those who have ever been online to access the Internet or World Wide Web, or to send and receive e-mail. This is not to suggest that the issue of disparities between Internet users and nonusers is unimportant, and indeed we need more research exploring reasons why people do not access the Internet (Katz & Rice, 2002; Selwyn, Gorard, & Furlong, 2005). But in this study, any remaining gaps in Internet use for information seeking after people pass the threshold of having ever been online are of concern:

H1a: Those with higher education levels will be more likely to seek cancer-specific information on the Internet than will those with lower education.

H1b: Ethnic majorities will be more likely to seek cancer-specific information on the Internet than will ethnic minorities.

In addition, these relationships of online information seeking with education and ethnicity are expected to be modified by contingent factors. This study considers two factors: individual motivation for online seeking and ease of connection to the Internet. Motivational factors, such as motivation, interest, concern, and involvement, have been suggested to further influence the effects of SES on knowledge gaps (Ettema & Kline, 1977; Kwak, 1999; Viswanath, Kahn, Finnegan, Hertog, & Potter, 1993; Yows et al., 1991). As an indicator of motivation, individuals' perceived threat, risk, and susceptibility to certain disease or health conditions have often been used in research on health knowledge gaps (e.g., Ettema et al., 1983; Yows et al., 1991). It is expected that gaps in Internet use for cancer information between different social groups will become smaller among those who are highly motivated to seek cancer information, whereas gaps will be larger among those who are less motivated:

H2a: Gaps in Internet use for cancer-specific information between high and low education groups will depend on one's perceived risk of cancer such that the gap is less likely to exist among those higher in perceived risk.

H2b: Gaps in Internet use for cancer-specific information between ethnic majorities and minorities will depend on one's perceived risk of cancer such that the gap is less likely to exist among those higher in perceived risk.

Individuals' online information seeking is also likely to be determined by whether or not easy access or good-quality connection to the Internet is available to them (Katz & Rice, 2002). Having an easy-to-use connection may let individuals overcome an ability deficit and enhance their Internet use to seek information about cancer. This study examines whether or not individuals have Internet access at home and, if so, whether they have low- or high-speed connections. Of interest is how this contextual condition moderates the

relationships of education and ethnicity with online cancer information seeking:

H3a: Gaps in Internet use for cancer-specific information between high and low education groups will depend on an easy-to-use connection to the Internet such that the gap is less likely to exist among those with easier-to-use connections.

H3b: Gaps in Internet use for cancer-specific information between ethnic majorities and minorities will depend on an easy-to-use connection to the Internet such that the gap is less likely to exist among those with easier-to-use connections.

Gaps in Knowledge About Cancer

When examining gaps in cancer knowledge, it should be noted that the initial knowledge gap hypothesis is primarily concerned with the multivariate phenomena of gaps (Eveland & Scheufele, 2000). The focus of the hypothesis is placed on the differences in the relationship between one variable (e.g., education) and another variable (e.g., knowledge) across levels of a third variable (e.g., time or media publicity), not on the mere bivariate relationship between education and knowledge or between media publicity and knowledge (Eveland, 1997; Eveland & Scheufele, 2000; Gaziano, 1983; McLeod, Bybee, & Durall, 1979). Tichenor et al. (1970) describe two distinctive methods to test this multivariate hypothesis empirically. First, whether the correlation between education and knowledge increases over time as media information enters the society can be examined with longitudinal data. Alternatively, the cross-sectional correlation of education with knowledge at one point in time can be compared at a macro level between issues high in media coverage and those low in coverage (Viswanath & Finnegan, 1996).

An additional method of testing the hypothesis is introduced by researchers who examine knowledge gaps at a single point in time and regarding a single issue (e.g., Eveland & Scheufele, 2000; Kwak, 1999; McLeod et al., 1979). They suggest comparing the correlation between education and knowledge for individuals high in media use with the correlation for individuals low in media use. That is, the gap in knowledge between high and low education groups among individuals high in media use is compared with the knowledge gap among those low in media use. In this case, the input of media information is measured with the amount of media exposure at the individual level (Eveland & Scheufele, 2000), in comparison to the macro-level variable of media publicity proposed by Tichenor et al. (1970).

Measuring individuals' actual exposure to information can be especially useful to study knowledge gaps with regard to the Internet because of the distinctive characteristics of this media channel. The Internet requires more active engagement of users than do television or newspapers, and incidental exposure to information is less likely to occur online. As a result, the presumption of the initial knowledge gap hypothesis that the aggregate information environment (i.e., media publicity) would lead to individual exposure may not hold true for the Internet. Based on this reasoning, this study employs the individual-level method to examine the sizes of cancer knowledge gaps between the more and the less educated, and between ethnic majorities and minorities, and how they vary with the level of Internet usage:

H4a: Gaps in cancer knowledge between high and low education groups will depend on individuals' Internet use for cancer-specific information such that the gap will be larger among those who seek cancer information than among those who do not.

H4b: Gaps in cancer knowledge between ethnic majorities and minorities will depend on individuals' Internet use for cancer-specific information such that the gap will be larger among those who seek cancer information than among those who do not.

Perceived risk of cancer and ease of connection to the Internet are expected to work as contingent conditions in influencing cancer knowledge gaps as well. Greater perception of cancer risk is thought to motivate individuals to learn more from online information seeking, so that it may reduce the relative size of knowledge gaps by online seeking among different social segments. Also, having an easy, good-quality connection to the Internet is expected to decrease the relative size of knowledge gaps by online information seeking among different social groups. Three-way interactions among the main predictors (education and ethnicity), Internet use for cancer information, and contingent variables (perceived cancer risk and easy-to-use connection) are proposed in the following hypotheses:

H5a: The associations between Internet use and cancer knowledge gaps among different education groups will be moderated by one's perceived risk of cancer such that the association will be weaker in those higher in perceived risk.

H5b: The associations between Internet use and cancer knowledge gaps among different ethnic groups will be moderated by perceived risk of cancer such that the association will be weaker in those higher in perceived risk.

H6a: The associations between Internet use and cancer knowledge gaps among different education groups will be moderated by easy-to-use Internet connections such that the association will be weaker in those having easier-to-use connections.

H6b: The associations between Internet use and cancer knowledge gaps among different ethnic groups will be moderated by easy-to-use Internet connections such that the association will be weaker in those having easier-to-use connections.

METHODS

Data for this study came from the 2003 Health Information National Trends Survey (HINTS) conducted by the National Cancer Institute. HINTS was designed to collect nationally representative data every 2 years about the U.S. public's need for, access to, and use of cancer-related information, as well as their perceptions and behaviors relevant to cancer (National Cancer Institute, 2003).

Sample

A subsample of HINTS respondents was used in this study: individuals who did "ever go on-line to access the Internet or World Wide Web, or to send and receive e-mail" (N = 3,982; 62.5% of the total sample). HINTS respondents were a national probability sample of adults age 18 or over in the United States (National Cancer Institute, 2003). The sample was obtained through random digit dialing from all telephone exchanges in the United States, with oversampling of exchanges with high numbers of African Americans and Hispanics. During the household screener, one adult was sampled within each household and recruited for the extended interview (Rizzo, 2003). The response rate for the household-level screening interview was 55%[1] and the rate at which sampled persons from the household voluntarily completed the full HINTS interview was 62.8% (Nelson et al., 2004).

Respondents included in this study were overall better educated and had greater income when compared to the entire sample of HINTS respondents (see Appendix). Four percent of the respondents had some high school education or less, 22% had completed high school or obtained a GED, 31% had some college or technical school education, and 44% earned bachelor's or advanced degrees. The race/ethnicity of the sample included: 8% Hispanics, 76% non-Hispanic White Americans, and 11% non-Hispanic African Americans. Forty-one percent were men and 57% were married, with an average age of 43. In addition, 15% assessed their own health status as excellent, 35% as very good, 34% as good, 13% as fair, and 3% as poor. Ninety-one percent of the sample had health insurance coverage; 10% reported having ever been diagnosed with cancer, and 65% reported having at least one immediate family member who had been diagnosed with cancer.

Measurements of Variables

Predictor variables. Education and race/ethnicity were the main predictors. The highest grade or level of school respondents completed was used as an indicator of SES: 1 (*high school graduate or lower education*), 2 (*some college or technical schoo*l), and 3 (*college graduate or more advanced*). To identify respondents' race/ethnicity, four dummy variables were created: non-Hispanic White American, non-Hispanic African American, and Hispanic American, and other ethnic groups. White Americans were defined as ethnic majorities and the others were regarded as ethnic minorities.

Internet use variable. Respondents' Internet use for cancer-specific information in the past 12 months was assessed: 1 (*did not use the Internet to look for health or medial information*), 2 (*used the Internet for cancer-unspecific health information*), 3 (*used the Internet for cancer-specific informatio*n); M = 2.02, SD = .81.

Contingent variables. Respondents' perceived risk of getting cancer ("How likely do you think it is that you will develop cancer in the future? Would you say your chance of getting cancer is . . . ?") was used as an indicator of individual motivation: 1 (*very or somewhat low*), 2 (*moderate*), 3 (*somewhat or very high*). Those who reported they had been diagnosed with cancer (N = 396) were not asked this question and were given a score of 3 on this variable (M = 1.85, SD = .80). Ease of connection to the Internet was assessed with: 1 (*no Internet connection at home*), 2 (*Internet connection at home mainly through a telephone modem*), 3 (*Internet connection at home mainly through advanced-quality device such as cable or satellite modem and DSL modem*); M = 2.12, SD = .63).

Criterion variable. Respondents' knowledge about cancer was measured using seven items available in the HINTS.[2] Cancer knowledge was divided into knowledge about cancer prevention and lifestyles and knowledge about screening because of the possible difference in the topical constructs underlying them. Each knowledge topic was measured using both open-ended items for respondents' information holding, regardless of its accuracy, and fact-based items for their correct knowledge (Yows et al., 1991).[3] Related to lifestyle behaviors, there were two open-ended questions ("Can you think of anything people

[1]This rate was calculated using the "Standard Definitions" of the American Association for Public Opinion Research (2001, for detailed information about the HINTS administration, see Nelson et al., 2004).

[2]The criteria for the eligibility of knowledge items were developed to cope with limitations of secondary data analysis. The topics of knowledge were first restricted into lifestyle behaviors and screening tests. Items that were thought to measure beliefs, not knowledge, were not eligible for inclusion (e.g., how much do you agree or disagree with the statement that there is not much people can do to lower their chances of getting cancer?). In addition, to maximize statistical power, items that were either randomly assigned to a sub sample or asked only of relevant sub groups (e.g., only females got a question about mammograms and only males got a questions about PSA) were not included.

[3]Measures of information holding tap what respondents believe they know about cancer prevention and screening instead of what they must know (Yows et al., 1991). Including both open-ended items and close-ended factual items is expected to reduce potential middle-class bias of knowledge items (Bonfadelli, 2002; Viswanath & Finnegan, 1996).

can do to reduce their chances of getting cancer?" and "What specific changes should people make in their eating habits to reduce their chances of getting cancer?") and two factual questions ("How many servings of fruits and vegetables do you think a person should eat each day for good health?" and "Can exercise help to lower the chances of getting some types of cancer or does exercise not make much difference?"). Those who were able to mention any lifestyle behaviors for the open-ended questions were given a score of 1 (*having knowledge*), whereas those who could not were given a 0. For the factual questions, correct answers ("five or more servings" and "lowers chance of cancer") were coded as 1 and incorrect answers as 0. There were three items about screening tests: two open-ended questions ("You said people should get tested for cancer. What kinds of tests do you have in your mind?" and "Can you think of any tests that detect colon cancer?"), with respondents who mentioned any tests being given a score of 1 (vs. 0), and one factual question ("Getting regular checks for colon cancer increases the chances of finding cancer when it's easy to treat."), with those who gave a correct answer ("strongly agree") being coded as 1 (vs. 0). Finally, scores of each knowledge item were summed (lifestyle knowledge $M = 2.54$, $SD = 1.12$, *Range* = 0–4; screening knowledge $M = 1.47$, $SD = .76$, *Range* = 0–3; overall knowledge $M = 4.01$, $SD = 1.50$, *Range* = 0–7).

Control variables. Sociodemographic characteristics were used as control variables, including age (18–29, 30–39, 40–49, 50–59, and 60 or above), gender, and marital status. Other control variables included respondents' health status, ranging from 1 (*poor*) to 5 (*excellent*), family history of cancer (yes/no), and health insurance coverage (yes/no). Also, use of traditional mass media for health information was controlled. The most relevant measure in the HINTS was "How much attention do you pay to information about health or medical topics on/in [media source]?" For each medium (television, radio, newspapers, and magazines), responses were assessed on a 4-point scale ranging from 1 (*not at all*) to 4 (*a lot*) and averaged into an index ($M = 2.67$, $SD = .76$).

RESULTS

Table 1 presents the results from an ordinary least squares regression analysis predicting Internet use for cancer-specific information. Control variables were also included in the regression models, and all of them except marital status had significant associations with Internet use. There were statistically significant differences in Internet use for cancer information by one's education level and ethnicity, consistent with H1a and H1b (see Model 1 in Table 1). The better educated were more likely to use the Internet specifically to learn about cancer compared with those with lower education. African Americans and Hispanic Americans were less likely to seek cancer information online than were White Americans. The sample used in this study (all of whom had passed the threshold of having ever been online) was more skewed in terms of education and ethnicity than the general population; however, there remained gaps in online cancer information seeking depending on education attainment and ethnicity.

TABLE 1
OLS Regression Analysis Predicting Internet Use for Cancer-Specific Information

	Model 1	*Model 2*
Control variables		
Age	–.12***	–.11***
Male	–.09***	–.11***
Married or coupled	.02	–.00
Perceived health status	–.04*	–.03
Family history of cancer	.13***	.11***
Health insurance coverage	.04*	.04***
Traditional media use	.20***	.20***
Predictor variables		
Education	.13***	.12***
Hispanic American	–.07***	–.06***
African American	–.07***	–.06***
Other ethnic groups	.02	.02
Contingent variables and interaction		
Perceived cancer risk		.08***
Education × Risk		–.00
Hispanic American × Risk		–.03
African American × Risk		–.03
Others × Risk		–.03
Easy-to-use Internet connection		.15***
Education × Connection		–.00
Hispanic American × Connection		–.02
African American × Connection		.01
Others × Connection		.03*
R^2 (%)	11.5***	14.4***

Note. Coefficients are standardized regression coefficients (betas). White Americans was used as a reference category among the dummy variables of ethnicity.

*$p < .05$. ** $p < .01$. ***$p < .001$.

Model 2 of Table 1 indicates the roles that perceived cancer risk and ease of connection to the Internet played in predicting Internet use for cancer-specific information. These two variables and their interaction terms with education and ethnicity were newly added to the regression model.[4] It was found that perceived cancer risk worked as a motivational factor that encouraged people to go online to learn specifically about cancer. Having easy, better-quality Internet connections at home also drove people to seek cancer information on the Internet. However, the hypotheses about the interaction effect of perceived risk with education and with

[4]In order to reduce potential problems with multicollinearity, all variables were centered before their interaction terms were computed (Cronbach, 1987; Eveland, 1997). That is, the mean value of each variable was subtracted from the original value prior to the computation of the product terms (e.g., education multiplied by Internet use).

TABLE 2
OLS Regression Analysis Predicting Knowledge About Cancer

	Lifestyle Knowledge	*Screening Knowledge*	*Overall Knowledge*
Control variables			
Age	.05**	.24***	.16***
Male	−.12***	−.10***	−.14***
Married	.06***	.09***	.08***
Perceived health status	.10***	.06***	.11***
Family history of cancer	.05**	.06***	.07***
Health insurance coverage	.04*	.07***	.06***
Traditional media use	.18***	.14***	.20***
Incremental R^2	.081***	.140***	.143***
Predictor variables			
Education	.18***	.16***	.21***
Hispanic American	−.11***	−.11***	−.13***
African American	−.09***	−.07***	−.10***
Other ethnic groups	−.04*	−.08***	−.07***
Incremental R^2	.047***	.040***	.067***
Internet use variable and interaction			
Internet use for cancer information	.04*	.11***	.08***
Education × Internet Use	−.02	.04*	.00
Hispanic American × Internet Use	−.00	−.00	−.01
African American × Internet Use	.00	.01	.01
Others × Internet Use	.00	.02	.01
Incremental R^2	.002	.012***	.006***
Contingent variables and interaction			
Perceived cancer risk	−.01	.05***	.02
Education × Internet Use × Risk	.02	−.00	.02
Hispanic American × Internet Use × Risk	.04*	.01	.03*
African American × Internet Use × Risk	−.00	−.03*	−.02
Others × Internet Use × Risk	.01	.03	.02
Easy-to-use Internet connection	.01	−.01	.00
Education × Internet Use × Connection	.01	−.02	−.00
Hispanic American × Internet Use × Connection	.00	−.01	−.00
African American × Internet Use × Connection	−.01	−.02	−.02
Others × Internet Use × Connection	−.02	−.00	−.02
Incremental R^2	.004	.007*	.005
R^2 (%)	13.4***	19.9***	22.1***

Note. Coefficients are standardized regression coefficients (betas). In the last block, all of the two-way interaction terms between predictor variables and contingent variables were entered as well (e.g., Education × Risk, Hispanic American × Risk, African American × Risk, Others × Risk, Education × Connection, Hispanic American × Connection, African American × Connection, Others × Connection). None of them had statistically significant associations with cancer knowledge other than African American × Connection on screening knowledge (ß = .05, $p < .01$ for screening knowledge).

*$p < .05$. ** $p < .01$. ***$p < .001$.

ethnicity on online cancer seeking (H2a and H2b) were not supported. Also not supported were the hypotheses concerning the interaction of easy-to-use Internet connection with education and ethnicity (H3a and H3b). Perceived risk of cancer and having an easy-to-use connection were main predictors of Internet use for cancer information rather than moderators of the effects of education and ethnicity on Internet use.[5]

Table 2 presents the results of the ordinary least squares hierarchical regression models predicting two types of knowledge (one about cancer prevention and the other about cancer screening) and the overall knowledge index. The analysis used a statistical interaction between predictor variables (e.g., education) and media variables (e.g., Internet use) as an alternative way to compare correlations between predictors and knowledge across different levels of media use (Eveland & Scheufele, 2000; Kwak, 1999; McLeod et al., 1979). Control variables were first entered to the analysis, followed by education and ethnicity in the next step, and Internet use and its interaction terms with either

[5]There was one exception to this pattern, despite a weak association, such that Asian Americans and other non-Hispanic, non-African minorities showed particularly greater increase in online seeking when an easy-to-use Internet connection was available at their home (ß = .03, p< .05).

education or ethnicity in the third step. The last block included the hypothesized contingent variables, their two-way interaction terms with either education or ethnicity, and the three-way interactions with education (or ethnicity) and Internet use.[6]

Control variables as a block accounted for about 8% to 14 % of the total variance of the dependent variable, with age and traditional media use for health information making the strongest contributions. Education and ethnicity were also strong predictors for knowledge about cancer prevention and screening, accounting for about 4% to 7% of its variance among online users. More educated people had greater cancer knowledge than less educated people. Hispanics and African Americans had lower levels of knowledge compared to White Americans.

Internet use for cancer-specific information had a favorable relationship with cancer knowledge after controlling for control variables, education, and ethnicity. In terms of the topic of knowledge, Internet use was a stronger predictor of knowledge about cancer screening over and beyond traditional media use than it was for knowledge about lifestyle behaviors. It seems that respondents were more likely to learn about cancer screening from their online seeking compared to topics like the cancer–lifestyle link with heavy coverage in mass media.

The hypotheses about the multivariate phenomena of knowledge gaps (i.e., gaps by education and ethnicity across levels of Internet usage, H4a and H4b) were supported in one case: the interaction between education and Internet use for cancer information on knowledge about cancer screening.[7] The other interaction terms failed to attain a significance level of $p < .05$. As shown in Figure 1, the difference in means of cancer screening knowledge among the three education groups was greater when people sought information specific to cancer on the Internet. For an alternative method

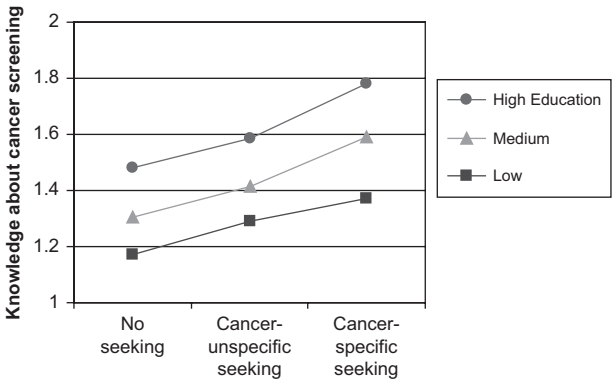

FIGURE 1 Cancer screening knowledge by education and online seeking. *Note.* Y axis presents the predicted values of cancer screening knowledge, which were acquired from multiple regression after controlling for other relevant variables ($M = 1.48$, $SD = .33$).

of explaining this interaction pattern (Eveland & Scheufele, 2000), the correlations between education and screening knowledge[8] at different levels of online seeking were compared: the correlation was .28 ($p < .001$) among those who did not use the Internet for health information, .39 ($p < .001$) for those who used the Internet for general health information, and .44 ($p < .001$) among those who used the Internet for cancer-specific information. This finding, although the aforementioned beta value of the interaction term was small, may suggest widening knowledge gaps as a result of Internet usage gaps particularly when the topic of knowledge, for example, screening, was less prevalent in mass media channels and more information could be learned from active searching on the Internet.

The last block of regression models in Table 2 made a relatively small contribution to accounting for the variance of cancer knowledge. Respondents' perceived risk of cancer was associated with screening knowledge but not with lifestyle knowledge. Having an easy-to-use Internet connection at home had no relationship with cancer knowledge. Data supported neither the hypotheses about the three-way interaction among education, Internet use for cancer-specific information, and perceived cancer risk (H5a) nor the interaction among education, Internet use, and easy-to-use Internet connections (H6a). The expected three-way interaction of ethnicity by Internet use by easy-to-use connection (H6b) was not observed either. By contrast, the hypothesized interaction among ethnicity, Internet use, and perceived risk (H6a) was found with Hispanic Americans on lifestyle knowledge and on overall cancer knowledge. Figure 2 shows that the relationship between Hispanics' online seeking and cancer knowledge was modified by one's perceived risk of cancer. Among those who were low in perceived risk

[6]In addition to the regression models reported in Table 2, four different models were tested after each type of knowledge was further divided into open-ended knowledge (i.e., knowledge held by respondents regardless of its accuracy) and factual knowledge. Patterns observed were consistent with those presented in Table 2, but respondents' education level had stronger associations with knowledge holding than factual knowledge for both cancer prevention and detection. Interestingly, the two-way interaction between education and Internet use for cancer information on screening knowledge (see Table 2) remained statistically significant when predicting knowledge holding whereas it was not significant when predicting factual knowledge about cancer screening; the three-way interaction term among ethnicity, Internet use for cancer information, and perceived cancer risk (which was statistically significant in Hispanic Americans as shown in Table 2) had a significant association with knowledge holding but not with factual knowledge about lifestyle behaviors. Further research is necessary for the relationship between online information seeking and knowledge holding.

[7]As the relationship between education and cancer knowledge was positive and the relationship between Internet use and knowledge was positive, a positive sign for the interaction term indicates a stronger relationship between education and knowledge for respondents with higher levels of Internet use.

[8]The predicted values of screening knowledge, which were acquired from multiple regression after controlling for other relevant variables, were used for the examination of these correlations.

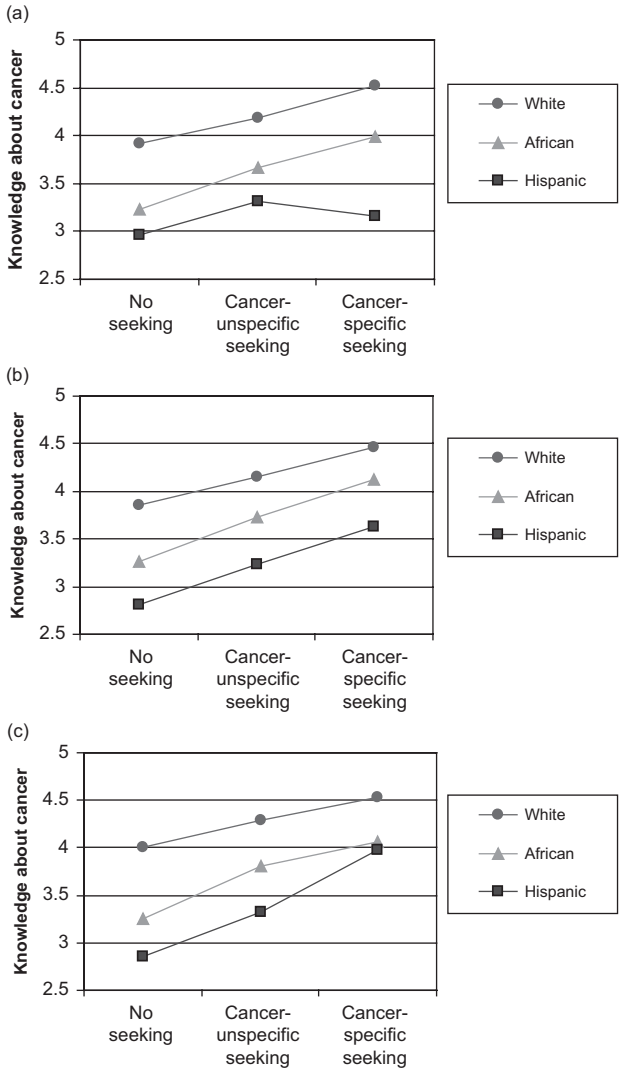

FIGURE 2 Overall cancer knowledge by ethnicity, online seeking, and perceived cancer risk. (a) Low-risk group; (b) moderate-risk group; (c) high-risk group. *Note.* Y axis presents the predicted values of cancer knowledge acquired from multiple regression after including controls (M = 4.05, SD = .70).

and thus had low motivation, Hispanics had much less knowledge than White Americans when they sought cancer information on the Internet (Figure 2a). The knowledge gap between Hispanics and White Americans from online cancer seeking was reduced among those with moderate levels of perceived risk (Figure 2b). The knowledge gap was less likely to exist among those high in perceived risk such that highly motivated Hispanics learned relatively more about cancer from their online cancer seeking than did others (Figure 2c). That is, the association between Internet use and ethnicity-based knowledge gap depended to some degree on the extent to which people were involved with cancer risk.

DISCUSSION

Applying the knowledge gap hypothesis, this study explained the role of Internet use for cancer-specific information in enlarging or reducing gaps in cancer knowledge among different social groups. First, this study found education and racial/ethnic gaps in Internet use to learn specifically about cancer, even after individuals crossed the threshold of having ever used the Internet. Moreover, data supported the significant roles of Internet use and a motivational factor (but not a technology factor) to some extent in modifying the association of education and ethnicity with knowledge acquisition. The gap in cancer screening knowledge among different education groups became larger as people sought cancer-specific information on the Internet. The gap in cancer lifestyle knowledge acquired from online seeking was less likely to exist between Hispanics and White Americans when people had higher levels of perceived cancer risk.

Gaps in Use of the Internet for Cancer-Specific Information

The findings of this study suggest that the digital divide is not only a matter of physical access to the Internet but also an issue of its use for specific purposes, consistent with the conclusions of many researchers (e.g., Bonfadelli, 2002; DiMaggio et al., 2004; Gunkel, 2003; Katz & Rice, 2002; Selwyn, 2004; Van Dijk & Hacker, 2003). Focusing on Internet use to seek cancer information among those who have ever been online, this study shows there are remaining gaps in Internet usage by educational attainment and ethnicity. Although cancer, the second leading cause of U.S. deaths, is a relevant issue to almost everyone, less educated people, Hispanics, and African Americans seem not to take advantage of their Internet access to learn more about the disease. This inequality in online cancer information seeking was not moderated by perceived cancer risk or having easy-to-use Internet connections, but both variables had main effects on online seeking.

Studying gaps in use of the Internet for cancer information is an important step that leads to the next step concerning subsequent gaps in knowledge acquisition about cancer between different social groups. Inequalities in online health information seeking may prevent underserved populations from acquiring knowledge essential to healthy life. As Viswanath (2005) says, these inequalities in accessing cancer information may provide one explanation of the reasons behind the strong links of education and ethnicity to cancer incidence and mortality. Findings on gaps in use of the Internet for cancer information need to be followed by research concerning gaps in various potential outcomes of Internet use, such as adopting healthier lifestyle choices and prevention behaviors, that is, "communication effects gaps" in general (Shingi & Mody, 1976).

Education- and Ethnicity-Based Gaps in Cancer Knowledge as an Outcome of Online Seeking

As one outcome of Internet usage gaps, this study looked at gaps in knowledge about cancer prevention and screening among different education groups and among White Americans, African Americans, and Hispanics. The multivariate phenomenon of knowledge gaps by Internet use between high and low education groups was found with cancer screening knowledge, but not with lifestyle knowledge. This finding may raise our concern that Internet use enlarges education-based gaps in knowledge about a certain topical domain of cancer. Because online seekers are able to learn information about cancer from other mass media as well, the more educated may not gain extra knowledge on some topics (e.g., the role of lifestyles in preventing cancer) from their online seeking, just as the less educated people, and therefore online seeking may not enlarge the education-based knowledge gaps. But if the cancer topics are less widespread in mass media and involve more complicated issues, the better educated may obtain additional information about the topics from the Internet more easily than those with less education.

This is why it is important for researchers and public health practitioners to consider how to enhance individuals' online search skills or abilities, especially in low education groups. Individuals' ability to find valuable and relevant information online allows them to use the Internet to their maximum benefit (Hargittai, 2002, 2004). If the less educated end up feeling confused or rarely helped with the information they obtain from the Internet, then merely using or searching the Internet hardly solves the problem of the digital divide (Wilson, 2000). In fact, knowledge about cancer screening among college graduates or those with advanced degrees was significantly associated with their self-reported usefulness of the cancer information they got from the Internet ($r = .10$, $p < .01$), whereas knowledge had no relationships with perceived usefulness of information obtained online in lower education groups (high school graduates or the less educated, $r = -.02$, *ns*; and those with some college or technical school experience, $r = .02$, *ns*).[9] Given these findings, more research is needed to analyze the actual patterns of online search among the less educated (e.g., time spent, the types of Web sites often visited, the credibility of information obtained, etc.) and to consider what guidance is necessary to improve their search skills as one solution to reduce online-based knowledge gaps.

In addition, this study found that respondents' ethnicity was associated with knowledge about cancer prevention and screening after their education levels were controlled for, and suggested the importance of further concerns about ethnicity-based knowledge gaps in the health communication field. More interesting, the ethnicity-based knowledge gap was found to be moderated by Internet use for cancer information and a motivational factor. The gap in cancer knowledge acquired from Internet seeking was less likely to exist between Hispanic Americans and White Americans among those who had higher levels of perceived cancer risk and motivation to research cancer issues, compared to those with lower levels of cancer risk. This finding supports the motivation contingency model (see Bonfadelli, 2002; Kwak, 1999) and extends its focus beyond education into ethnicity. In the same sense as Kwak's (1999) suggestion to research education-based gaps, it is necessary to examine the roles of motivational factors in moderating ethnicity-based knowledge gaps and media-effected knowledge gaps between ethnic majorities and minorities. Another important aspect of the digital divide that public health practitioners should consider is the crucial role of motivation and involvement in reducing cancer knowledge gaps.

Respondents' easy-to-use connection to the Internet was not found to moderate the associations between Internet use and education- or ethnicity-based knowledge gaps. This finding suggests, at least among those who have ever been online, that this technology factor does not play a strong role in enlarging knowledge gaps. What are more important at this stage are individuals' needs and motivations to seek health information on the Internet, skills for findings useful information, and the ability to hold the information they find.

Measurements of Cancer Knowledge

When the aforementioned findings about the two-way or three-way interaction are interpreted, it should be noted that their effects are statistically significant but are not strong. One explanation for this can be little variance in cancer knowledge because this study used the reduced, somewhat homogeneous sample. Because respondents who had ever been online were more educated and more informed about cancer than the HINTS sample as a whole, the sample used in this study might be more likely to approach the theoretical maximum for the knowledge measure (i.e., ceiling effects). Another explanation could be that the measures contained in the HINTS data were not originally developed for the examination of the knowledge gap hypothesis or the digital divide issue, and as a result, this study was constrained to the measures that could be obtained from the data set when testing the hypotheses. Although carefully developed in this study, the index of cancer knowledge may have some limitations in capturing the variance of its construct and representing the actual construct of knowledge. For example, knowledge about lifestyle behaviors assessed in this study might have been so broad or so prevalent among respondents that it failed to detect knowledge gaps widened by online information seeking. If knowledge about newly released information on cancer had been measured, stronger

[9]Those who have sought information about cancer on the Internet in the past 12 months (N = 1,357) were asked "Overall, how useful was the cancer-related information you got from the Internet?" (1 = not at all to 4 = very useful; M = 3.34, SD = . 64).

associations among the variables (e.g., the two-way interaction effect between education and Internet use on knowledge, and the three-way interaction among ethnicity, Internet use, and perceived risk on knowledge) may have been found.

In addition, the conceptual and operational measures of health and cancer knowledge need to be further developed in examining knowledge gaps among different social segments. Compared to political knowledge (e.g., Eveland & Scheufele, 2000), health knowledge lacks measures of which the validity and reliability have been carefully tested and largely shared in the field. This may be because health knowledge has been often studied as an outcome of exposure to a particular health campaign and knowledge items have been constructed based on campaign messages (e.g., Alcalay & Bell, 1996; Viswanath et al., 1993). From the Internet, outside the context of campaigns, however, a larger amount and more kinds of information about health (or cancer in specific) can be learned. Future studies should develop a better way to tap into knowledge acquisition, including the comparison between different topical constructs of knowledge (e.g., a variety of cancer prevention and detection options related to different types of cancer) and between different operationalization methods (e.g., open vs. closed-ended methods).

Conclusion

The limitations of this study should be noted. The observed associations with the cross-sectional data do not justify causal claims between online seeking and cancer knowledge. There is a possibility that the association reflects some reverse causal influence that individuals who know more about cancer are more likely to engage in and report online seeking. Also as mentioned before, being a secondary data analysis, this study has limitations in that the construction of cancer knowledge measures was confined to the items included in the HINTS data.

Despite these limitations, this study offers meaningful findings about the size of cancer knowledge gaps between different social groups, and how the knowledge gaps vary with the level of Internet usage, perceived cancer risk, and easy-to-use Internet connections at an individual-level. This microlevel analysis compares the relationship between education (or ethnicity) and knowledge between individuals high in online seeking and low in online seeking. Although the generally preferred method for testing the knowledge gap hypothesis is to use longitudinal data and examine the macrolevel media publicity and gaps in knowledge, this study notes that Internet use is difficult to measure at a macrolevel. As the Internet invites more active engagement of information seeking than does traditional mass media, high publicity of cancer information online may not necessarily be linked to individuals' high access to the information. Therefore, this study suggests using the interaction between education and Internet use as the statistical test when examining cross-sectional data to test the knowledge gap hypothesis. Nevertheless, this study acknowledges that only a longitudinal design can detect actual changes in gaps. A microlevel, longitudinal design can be an option for studying changes in knowledge gaps across different groups, respectively for those high and low in Internet use. Such a longitudinal design will also be helpful in permitting the claims of causal direction implied by the cross-sectional data of this study and in separating out the temporal order.

In summary, data from a national survey suggest that cancer disparities existing among different social segments can be explained to some degree by gaps in knowledge about cancer prevention and screening as a result of Internet use among these groups. With online information seeking strongly related to education levels and ethnicity, the education- and ethnicity-based knowledge gaps should be approached in multiple steps: Internet access, usage, skills, and knowledge. Data also suggest higher motivation owing to greater perceived risk of cancer may attenuate the knowledge gaps. Although motivation may not entirely overpower education or ethnicity, it is still important to enhance motivation and interest in cancer issues to reduce information inequalities, especially in socially disadvantaged groups.

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APPENDIX

Sample Characteristics: All Respondents Versus Internet Users

	All Respondents[a]*(%)*	*Internet Users*[b]*(%)*
Highest level of education		
Some high school or less	12	4
High school graduate	30	22
Some college or technical school	27	31
Bachelor's or advanced degree	31	44
Annual household income		
<$15,000	12	5
$15,000 to <$25,000	18	11
$25,000 to <$35,000	14	12
$35,000 to <$50,000	17	19
$50,000 to <$75,000	17	22
≥$75,000	22	31
Race/Ethnicity		
Hispanic	13	8
Non-Hispanic White	71	76
Non-Hispanic African/Black	12	11
Age		
18–29	16	20
30–39	20	25
40–49	21	24
50–59	17	17
≥60	26	14
Gender (Male)	40	41
Marital status		
Married	53	57
Member of an unmarried couple	4	4
Health insurance (covered)	87	91
Health status		
Excellent	13	15
Very good	31	35
Good	34	34
Fair	18	13
Poor	5	3
One's own cancer history	12	10
Family members' cancer history	63	65

[a]2003 Health Information National Trends Survey. [b]The present sample.