Health Disparity in Effective Cervical Cancer Screening: Findings from a National Survey of U.S.

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Abstract

Background: Cervical cancer is one of the most common causes of cancer death for women, but it can often be detected early and sometimes even prevented entirely by having regular tests. An effective way to prevent cervical cancer is to have screening tests. Even though cervical cancer screening programs are implemented in many countries and regions especially in developed countries, cervical cancer incidence has not been effectively controlled and there is still certain health disparity in the population. Inappropriate screening frequency may be the cause of the health disparity.

Methods: Drawing on the data from the 2017 Health Information National Trends Survey (Cycle5.1), a national survey conducted by the National Cancer Institute (NCI), we characterized cervical cancer screening (CCS) as two dimensions by the item of screening frequency, namely, active screening and effective screening. We compared the differences between these two screening behavior applying ordered logistic regression and binary logistic regression, and explored the mechanisms of effective screening.

Results: The impact factors differed between active screening and effective screening based on theory. Only self-efficacy ($\beta=0.16$, $p=0.023$) had a positively significant association with active screening behavior and both online health information seeking ($\beta=-0.102$, $p<0.001$) and social media participation ($\beta=-0.466$, $p=0.001$) negatively and significantly influenced effective screening behavior. Second, a theory-based mechanism of effective screening behavior found that traditional health perception factors no longer influence effective screening behavior, while environmental factors (social media) significantly reduce women's effective screening. In addition, the higher the level of education, the less inclined to conduct effective screening, but the more inclined to active screening for cervical cancer.

Conclusions: Our results indicate that while the Internet has become the main channel through which women acquire health resources, and social media has become a main platform for people to obtain health information, online information cannot guide people to engage in appropriate healthy behaviors. Overloading of online health information and digital divide may cause excessive screening or screening avoidance. Consequently, we must pay attention to the health disparity caused by unreasonable health behaviors caused by factors such as environmental factors and the divide in the use of IT.

Introduction

Cervical cancer is one of the most common causes of cancer death for American women. The American Cancer Society estimates that about 13,800 new cases of invasive cervical cancer will be diagnosed, and about 4,290 women will die from cervical cancer in the United States in 2020 [1]. An effective way to prevent cervical cancer is to have screening tests. Cervical cancer can often be detected early, and sometimes even prevented entirely, by having regular Pap tests [2]. If detected early, cervical cancer is one of the most successfully treatable cancers. Since the implementation of various cancer screening and promotion programs in the United States, awareness of cervical cancer among American women has increased [3]. The cervical cancer death rate dropped significantly with the increased use of the Pap test.

But little has changed in the last 10 years. Health disparities still exist in cervical cancer incidence and mortality [4].

Health disparities have been viewed as a chain of events signified by a difference in: (1) environment, (2) access to, utilization of, and quality of care, (3) health status, or (4) a particular health outcome that deserves scrutiny [5–7]. Consequently, health disparities in cancer screening can be interpreted as differences in health outcomes due to implemented screening measures [8]. Recent research on health disparities in screening for female (mainly about breast and cervical cancer) focuses primarily on the gaps in screening enthusiasm and compliance in: 1) special groups such as transgender [9], disability [10], different races [11, 12]; 2) socioeconomic status such as income, education, and health insurance types [13–15]; 3) social support [16, 17], family or community support [18, 19]. Underutilization of effective screening is one driver of disparities in cervical cancer incidence and mortality [20], but few studies have examined the disparity in health outcomes caused by the rationality of screening.

Cervical cancer screening (CCS) requires continuous screening at age-specific frequencies, thus an inappropriate screening frequency may cause the disparity in health outcomes. CCS has different frequency recommendations based on age, according to the cervical cancer screening guidelines issued by the American Cancer Society. This guideline was confirmed as a reasonable balance of benefits, harms, and costs from both a societal and health care sector perspective [21]. Over-screening is not conducive to finding anomalies and may cause unnecessary procedures, while insufficient screening cannot actually prevent cancer. In this study, we defined two screening behaviors for CCS based on the screening interval: (1) effective screening, in which case the screening interval meets the recommendation; and (2) active screening, which is measured by the length of the screening interval. We will investigate the disparity and mechanisms of CCS from different screening behavior.

The Health Belief Model (HBM) and Social Cognitive Theory (SCT) are often used to support the practice of health promotion and disease prevention, interventions [22–24]. HBM is a comprehensive model proposed as a framework to understand health behaviors such as cancer screening behaviors. It emphasizes on how one's perceptions cause motivation and movement, and lead to behavior [25]. SCT believes that the realization of human function can be explained according to the three-in-one model of mutual benefit. In this model, the three factors of behavior, cognition and environment play a role as mutual determinants [26, 27]. This study aims to select key factors affecting CCS behavior based on the two main theories to understand the potential mechanisms. We considered three factors as the perceptual factors of HBM, namely self-efficacy, perceived susceptibility and perceived severity. In addition, we regarded information channels such as patient-providers communication and social media as environmental factors of SCT. In this manner, we aim to find possible means to promote effective screening and reduce the health disparity.

Methodology

Data and Sample

Our study drew data from the first round of the fifth National Cancer Institute's Health Information National Trends Survey (HINTS 5 Cycle 1). HINTS is a nationally representative sample of adults in the United States since 2003. It aims to provide ever-changing information about how cancer risks are perceived and evaluate cancer information needs, access and usage. HINTS 5 Cycle 1 was conducted from January 25 to May 5, 2017 with a single-mode postal survey. The final HINTS 5 Cycle 1 sample consists of 3,285 respondents with an overall response rate of 32.39%.

In accordance with cervical cancer screening guidelines issued by the American Cancer Society, we only included female participants older than 21 years old. In addition, we excluded missing data on the key variables by listwise deletion, and ultimately obtained 911 valid samples.

Measures

The survey instruments included questions on CCS frequency, demographic variables, HBM related variables, SCT related variables, and several covariates.

Dependent Variable

CCS behavior: We defined two dependent variables to understand CCS behavior: active screening behavior and effective screening behavior.

1. *active screening behavior:* the corresponding item is “how long ago did you have your most recent Pap test to check for cervical cancer?”, and the answer was coded as six levels: never had a pap test; more than 5 years ago; more than 3, up to 5 years ago; more than 2, up to 3 years ago; more than 1, up to 2 years ago; a year ago or less. We considered the size of this code as the positivity of active screening. The greater the value, the more active the respondents have a Pap test.
2. *effective screening behavior:* which refers to whether the screening behavior meets the guidelines recommended by American Cancer Society, and was coded as a dummy variable. The guidelines suggest all women should begin CCS at age 21. Women aged 21 to 29 are expected to take a Pap test every three years. Beginning at age 30, women should be screened with a Pap test combined with an HPV test every five years as long as the test results are normal, and should continue until age 65. Another reasonable option for women aged 30 to 65 is to get tested every three years with only the Pap test. Women over age 65 who have had regular screening in the past 10 years with normal results should stop CCS. We can derive effective screening behavior directly from these guidelines. For example, a 29-year-old respondent who chose the CCS frequency item “more than 5 years ago” did not meet the guidelines, and her effective screening behavior would be coded as 0.

Independent Variables

Demographics: this study used sociodemographic factors including age, race, marital status, education level, occupation status and income level. Details of demographics are given in Table 1. In accordance with the screening guidelines, we recoded age as a three-level categorical variable: 21–29, 30–65, and older than 65.

Table 1
Sociodemographic characteristics of HINTS participants (N = 911)

Variables	N(%)-Mean(sd)	p-value	
		Active Screening	Effective Screening
Demographic variables			
Age		< 0.001	< 0.001
21–29	68 (8%)		
30–65	664 (73%)		
65 older	176 (19%)		
Race		< 0.001	0.46
Non-Hispanic white	641 (71%)		
Non-Hispanic black	144 (16%)		
Non-Hispanic other	26 (1%)		
Hispanic	97 (11%)		
Education		< 0.001	0.009
High school or less	141 (15%)		
Some college	236 (26%)		
College or more	531 (59%)		
Marital		< 0.001	< 0.001
Not married	394 (43%)		
Married/Living as married	514 (57%)		
Income		0.003	< 0.001
\$0 to \$19,999	131 (14%)		
\$20,000 to \$35,000	115 (13%)		
\$35,000 to \$50,000	112 (12%)		
\$50,000 to \$75,000	170 (19%)		
\$75,000 or more	380 (42%)		
Occupation		< 0.001	< 0.001

		p-value	
<i>Not Employed</i>	375 (41%)		
<i>Employed</i>	533 (59%)		
Medicare		< 0.001	< 0.001
<i>No</i>	676 (74%)		
<i>Yes</i>	232 (26%)		
Medicaid			
<i>No</i>	773 (86%)	0.01	0.08
<i>Yes</i>	122 (14%)		
Cancer history		< 0.001	0.001
<i>No</i>	765 (85%)		
<i>Yes</i>	143 (15%)		
Family cancer history		0.004	1
<i>No</i>	186 (20%)		
<i>Yes</i>	722 (80%)		
HBM-related variables			
Perceived severity		0.39	0.17
<i>No</i>	77 (8%)		
<i>Yes</i>	831 (92%)		
Self-efficacy	3.94 (0.8)	0.02	0.42
Perceived susceptibility	2.66 (1.09)	0.17	0.07
SCT-related variables			
Social media engagement		0.004	0.001
<i>No</i>	201 (22%)		
<i>Yes</i>	707 (78%)		
Seek health information		< 0.001	< 0.001
<i>No</i>	145 (16%)		
<i>Yes</i>	763 (84%)		
Patient-provider communication	3.38 (0.66)	0.84	0.73

Self-efficacy: it is defined as an individual's self confidence in his or her skills or abilities in taking care of their health. The corresponding item is "Overall, how confident are you about your ability to take good care of your health?". We reversed the original coding scheme and coded it from 1 (not confident at all) to 5 (completely confident).

Perceived severity: we used "do you think HPV requires medical treatment or will it usually go away on its own without treatment?" to measure perceived severity, and coded the answers from 1 (requiring medical treatment) to 0 (would usually go away on its own).

Perceived susceptibility: we used "how worried are you about getting cancer?" as the measurement item and coded the answers from 1 (not at all) to 5 (extremely).

Patient-provider communication: we used seven questions to measure patient-provider communication during the past 12 months with doctors, nurses, or other health professionals. Respondents were asked to assess the extent to which their providers engaged in communication. The example questions include "gave you the chance to ask all the health-related questions you had" and "gave the attention needed for your feelings and emotions". These survey items represent vital aspects of patient-centered care and used in several studies. The measurement scale of patient-centered is satisfactory ($\alpha > 0.7$, $CR > 0.7$), so we take the mean of these seven measurement items to measure this variable (1 = never, 2 = sometimes, 3 = usually, and 4 = always).

Social media engagement: we used "in the last 12 months, have you used the Internet for visiting a social networking site, such as Facebook or LinkedIn?" as the measurement item and coded the answers from 1 (yes) to 0 (no).

Seeking health information online: we used "Ever looked for information about health/medical topics?" as the measurement item and coded the answers from 1 (yes) to 0 (no).

Covariates Variables

Cancer history: two items measured cancer history (personal cancer history and family cancer history) and were coded as dummy variables. Medical insurance: we included two insurance types, namely Medicare and Medicaid. This item was assessed by asking the respondents whether they were availing of Medicare or Medicaid.

Statistical Analysis

Data were analyzed using R-4.0.0, and two types of multivariable logistic regression analyses were performed in our study to examine factors associated with different dimensions of the CCS behavior. Specifically, we used order logistic regressions to assess active screening and binary logistic regressions to analyze effective screening. Firstly, we used chi-square tests to identify independent variables that were significantly associated with active screening and effective screening behavior. In the following logistic regression models, we only included these independent variables. Then we conducted logistic regressions to analyze active screening and effective screening by a two-step procedure: (1) we only

included demographics and covariates to examine the health disparity in CCS behavior; (2) we added theoretical variables from HBM and SCT to understand how to change CCS behavior as well as its disparity.

Result

Descriptive statistics

After excluding missing values, only 911 valid samples remain. Our study reported frequency and percentage for categorical variables, and gave mean and standard deviation for continuous variables. The majority of respondents were 30–65 year-old non-Hispanic whites (71%) with college or higher education (59%), living as married (57%). Most of them had a high-income level of 75,000 or more (42%). But fewer people had Medicare insurance (26%). On average, respondents had high levels of self-efficacy in taking care of their health (mean = 3.94, sd = 0.795) in the five-point Likert scale. Besides, most of them perceived high levels of cervical cancer severity (92%), and worried slightly about getting cancer (mean = 2.66, sd = 1.089) in the five-point Likert scale. Most of the samples used the Internet to seek health information (84%) and visit a social networking site, such as Facebook or LinkedIn in the past 12 months (78%).

We used the chi-square test and Spearman's rank correlation coefficient to examine whether the categorical variables and continuous variables are significantly correlated with CCS behavior respectively. Table 1 showed the p-value in the last two columns. Beyond race, Medicaid and family cancer history, other sociodemographic variables were significantly correlated with effective screening behavior, while all independent variables were significantly correlated with active screening behavior. Thus, we only included these sociodemographic variables in following econometric models. In addition to patient-provider communication, we include other theoretical-based variables according to the correlation test results.

CCS behavior by age group

We gave the distribution of active screening and effective screening at different age groups in Table 2. More than half of women at age 21–29 took Pap test for less than a year and nearly one-fifth of them screened 1–2 years ago. The proportion of women's screening frequency was similar between 30–65 years old and 21–29 years old. At 65 years of age or older, 31% of women are screened within 1 year, and 32% of them had been screened more than 5 years ago. According to the screening guidelines, more than 80% of women's screening behaviors were effective at the age of 21–29, and 90% are effective at the age of 30–65. However, only 32% of screening behaviors in people 65 years and older meet the guidelines recommended frequency. Overall, among the 911 valid samples, 20% screening behavior was ineffective screening behaviors.

Table 2
Distribution of age groups in different screening behaviors

Variables	Age Group (N-%)			Total (%)
	age21-29	age30-65	age65 or older	
Active screening				
<i>Never had a pap test</i>	6 (9%)	3 (1%)	1 (1%)	1%
<i>More than 5 years ago</i>	1 (1%)	48 (7%)	57 (32%)	12%
<i>3–5 years ago</i>	2 (3%)	34 (5%)	18 (10%)	6%
<i>2–3 years ago</i>	5 (7%)	57 (8%)	15 (8%)	8%
<i>1–2 years ago</i>	10 (15%)	141 (21%)	31 (18%)	20%
<i>Less than 1 year</i>	44 (65%)	384 (58%)	54 (31%)	53%
Effective screening				
<i>Yes</i>	59 (87%)	616 (92%)	57 (32%)	80%
<i>No</i>	9 (13%)	51 (8%)	119 (68%)	20%

CCS behavior explained by HBM and SCT

We provided an in-depth understanding of CCS behavior through a two-step procedure: (1) we only included demographics and covariates to examine the health disparity in CCS behavior; (2) we added theoretical variables from HBM and SCT to understand how to change CCS behavior as well as its disparity. As we noted above, only independent variables that were significantly correlated with CCS behavior were included in logistic regression models (see Table 3).

Table 3
Compare the difference of CCS: active screening & effective screening

Variables	Active Screening		Effective Screening	
	Base Model	Full Model	Base Model	Full Model
Demographics variables				
Age				
age30-65	0.81	0.86	1.81	6.27
	(0.47,1.37)	(0.49,1.46)	(0.78,3.86)	(0.98,43.43)
age65 older	0.36**	0.38*	0.14***	0.1***
	(0.17,0.75)	(0.18,0.8)	(0.05,0.37)	(0.03,0.29)
Race				
<i>Non-Hispanic black</i>	1.62 *	1.61*	-	-
	(1.11,2.37)	(1.11,2.37)	-	-
<i>Non-Hispanic other</i>	1.56	1.46	-	-
	(0.7,3.77)	(0.66,3.53)	-	-
<i>Hispanic</i>	1.13	1.12	-	-
	(0.74,1.77)	(0.73,1.75)	-	-
Marital				
<i>Married/Living as married</i>	1.6**	1.57**	1.58	1.69 *
	(1.2,2.14)	(1.18,2.11)	(0.99,2.54)	(1.04,2.75)
Education				
<i>Some college</i>	0.95	0.94	0.43**	0.46*
	(0.64,1.42)	(0.63,1.4)	(0.22,0.8)	(0.24,0.87)
<i>College or more</i>	1.51*	1.48 ⁺	0.64	0.68
	(1.02,2.21)	(1,2.18)	(0.34,1.19)	(0.35,1.28)
Income				
<i>\$20,000 to \$35,000</i>	1.03	1.04	2.06	2.32*
	(0.63,1.68)	(0.64,1.71)	(0.99,4.33)	(1.11,4.96)
<i>\$35,000 to \$50,000</i>	1.16	1.14	1.23	1.31

Variables	Active Screening		Effective Screening	
	Base Model	Full Model	Base Model	Full Model
	(0.7,1.93)	(0.69,1.91)	(0.59,2.57)	(0.62,2.79)
<i>\$50,000 to \$75,000</i>	1.13	1.14	2.31*	2.46*
	(0.7,1.83)	(0.7,1.85)	(1.11,4.88)	(1.17,5.23)
<i>\$75,000 or more</i>	1.03	1	1.67	1.75
	(0.63,1.66)	(0.61,1.62)	(0.81,3.47)	(0.83,3.66)
Occupation	1.5	1.26	1.5	1.48
	(0.86,2.57)	(0.91,1.75)	(0.86,2.57)	(0.84,2.55)
Cancer history	1.02	1.01	1.06	1.08
	(0.72,1.47)	(0.7,1.45)	(0.62,1.85)	(0.62,1.92)
Family cancer history	0.97	0.96	-	-
	(0.7,1.34)	(0.69,1.32)	-	-
Medicare insurance	0.74	0.73	0.51	0.51
	(0.45,1.23)	(0.44,1.21)	(0.26,1.06)	(0.25,1.06)
HBM-related variables				
Self-efficacy		1.16 ⁺		1.1
		(0.98,1.37)		(0.84,1.44)
Perceived severity		1.1		1.11
		(0.97,1.24)		(0.91,1.36)
Perceived susceptibility		0.74		0.65
		(0.45,1.2)		(0.26,1.46)
SCT-related variables				
Social media engagement		0.89		0.57*
		(0.64,1.23)		(0.33,0.96)
Seek health information		1.17		0.87
		(0.81,1.69)		(0.48,1.55)
Observations	911	911	911	911
-2LL	2318	2312	602	594

Variables	Active Screening		Effective Screening	
	Base Model	Full Model	Base Model	Full Model
AIC	2361	2363	627	630
Notes: (1) Standard errors are in parentheses. (2) Significance levels: +: 0.1, *: 0.05, **: 0.01, ***: 0.001.				

Active screening: Taking 21–29 years old as a reference, women at age of 65 or older (OR = 0.38, CI = (0.18, 0.8)) were also unlikely to take an effective screening test. Non-Hispanic black (OR = 1.61, CI = (1.11, 2.37)) women with higher education (OR = 1.48, CI = (1, 2.18)) were more likely to have active screening. Only self-efficacy, a variable based on HBM theory, had a positively significant association with active screening behavior (OR = 1.16, CI = (0.98, 1.37)) at the significance level $p = 0.1$. It means that women with higher self-efficacy were more active in screening.

Effective screening: Taking 21–29 years old as a reference, women at age of 65 or older (OR = 0.1, CI = (0.03, 0.29)) were unlikely to take an effective screening test. Married women with Medicare insurance were likely to take the effective screening test. Women with higher education levels (OR = 0.46, CI = (0.24, 0.87)) were less likely to undergo effective screening. The variables from HBM had no significant effect on effective screening behavior. However, the environmental factors of SCT had a significant negative impact on effective screening behavior. Social media engagement (OR = 0.57, CI = (0.33, 0.96)) showed a significant negative association with effective screening, which means that the more frequency women visit social media, the less likely they will take an effective screening test. Seeking health information online also showed negative significant association with effective screening (OR = 0.87, CI = (0.48, 1.55)), which means the more women searching health information, the less likely they have the effective screening test.

Discussion

Prevalence of CCS

Nearly half of people had high enthusiasm for CCS and most screening behavior was effective, which means that since the implementation of the CCS program women's knowledge and awareness of cervical cancer has increased observably [28]. However, for those aged 65 or older, more than half of the women's screening behaviors may be inefficient. Current cervical cancer incidence and mortality data suggest that inappropriate cervical cancer screening (e.g., over-screening) can result in unnecessary medical procedures and worse health outcomes [29]. Previous research has also suggested the importance of effective CCS [28]. In the view of the two screening dimensions proposed in this study, most women at 21-29 years old whose screening behaviors were active and effective. However, a small number of people in the 30-65 age group had an ineffective screening, and over-screening may exist in the 65 or older age

group. This indicates that there are indeed invalid screening behaviors in different age groups that have caused health disparity [2, 20, 30].

Determinants and mechanisms of CCS

Our research found that disparities existed in CCS behavior across sociodemographic factors such as age, race, income, and education. Compared with those aged 21-29, women aged 65 or older were less likely to take the CCS test regardless of effective screening or active screening. In addition, non-Hispanic black women were more active in screening compared to non-Hispanic white, but there was no significant association with effective screening by race. Particularly, there were significant differences in screening behaviors between different education levels: the higher the level of education, the less inclined to conduct effective screening, but the more inclined to active screening for cervical cancer. This phenomenon can be interpreted as evidence of over-screening, as supported by previous studies [20]. These sociodemographic factors that influence whether to implement CCS have been discussed in previous studies, but little attention has been paid to the factors other than sociodemographic factors and little research has focused on the influencing mechanisms that actually affect effective screening [31, 32].

HBM and SCT are two widely accepted theories in explaining health behavior. After controlling for sociodemographic factors, we were somewhat surprised by our finding that none of the factors based on health belief model had a significant effect on effective screening, and only self-efficacy had a positive effect on active screening. According to the HBM, screening behavior is influenced by women's perception of their disease risk, perceived benefits of and barriers to participation, cues to action; and women's self-efficacy to participate [33]. We can thus explain in this study that women's self-efficacy is a key determinant of active CCS participation. These results may suggest that as the trial implementation of various screening programs progresses, women's knowledge of cervical cancer and screening awareness has generally increased. However, the HBM framework is primarily aimed at explaining the occurrence of healthy behaviors from the perspective of cognition and psychological perception [34, 35], and can no longer fully explain the behavioral mechanisms of reasonableness.

Based on the effect of environmental factors on the behavior proposed by SCT, we view health information acquisition channels as environmental factors that influence screening. Patient-provider communication proved to be an important offline channel, and high-quality communication between health care providers and their patients contributes to more adults receiving cervical and breast cancer screenings [36]. Nevertheless, our survey results suggest an insignificant correlation between patient-provider communication channels and respondents' screening behavior [37]. Information technology platforms such as social media have become popular communities and a key source of information for people to receive and share health experiences. Our research considers social media participation as a factor influencing women's cancer screening behaviors, and the statistical results confirm our view. Furthermore, this study found that online health information seeking behavior and social media

participation significantly negatively impact effective screening. Through the mediation analyses, we found that social networking participation fully mediates the negative impact of online health information seeking on effective screening. However, this result is inconsistent with some previous studies which showed that social media engagement could promote positive healthy behavior [38–40]. Though the reasons for these associations are not entirely clear, it is possible that the sample of this study was dominated by high-skilled and high-paying people, who preferred to search for health information online and pay more attention to health information on social network visiting. A large amount of health information available online, which has caused information overload that can mislead people. It is difficult for people to identify the information they really need and use it effectively, which could account for the third stage of digital divide, empowerment divide [41, 42]. Therefore, few people truly understand the power that digital technologies can give them, and it is unclear what they can do with the information technologies they use to promote their health. Many of them accept misleading information provided online, which has negative impacts on effective screening behavior.

In addition, health communication on the social media can affect the individual's health behavior, which can be explained by risk communication [43, 44] and social norms [45, 46]. People's awareness and knowledge have enhanced by years due to the cancer risk information communication, but overload cancer information may cause the avoidance of cancer screening [47, 48] or ineffective screening. For decades now, the main communication about cancer screening consisted of conveying to people that it was a good thing to do and that they should participate in it. However, as a result, the more women take part in social networking, the more difficult it is to conduct effective screening. Lenior's research also showed the clinical impact of a Twitter campaign to increase cervical cancer screening is yet to be evaluated [3]. We found that health information disseminated through social media may not be effective in a meaningful way. The engagement of users as information sources in social media greatly promotes the communication of health information. However, when compared with patient-provider professional health communication [36, 49], interpersonal communication via the Internet and social media made a significant difference in women's effective screening behavior. Those who attempt to search for screening information through social media or are exposed to the communication of such screening information may be unable to choose advice appropriate and therefore have experienced ineffective CCS.

Implications

These findings have shown some implications. On the one hand, it is a main trend that people seek health-related information and support online. However, information overload and misinformation could mislead people. Our data provide evidence that the effectiveness of Internet access still needs considerable attention when developing Internet-based public health interventions and communications. The government should work to improve the health information literacy of users and reduce the digital divide. On the other hand, social media would have a great potential to improve behavior change as interactive tools that encourage participation in CCS. To encourage effective screening behavior, we

cannot ignore the role of opinion leaders in interpersonal health communication. Therefore, health care providers could filter relevant CCS information and forward it to their social media followers, thereby facilitating effective screening uptake [44, 50].

Strengths and Limitations

Among the strengths of this study was the use of nationally representative samples to evaluate the disparity between women's active screening and effective screening of cervical cancer. Moreover, we uncovered the potential influence mechanism of women's effective screening. Specifically, our results reflect that the analysis of influence mechanism based on health theoretical frameworks is reliable, which provided the implications for government or health departments to design effective intervention plans and health promotion actions. Notably, our study extends previous studies that examined the influencing factors of CCS [51] by providing an in-depth understanding of women's behavior from an information technology perspective of effective screening.

Our study had several limitations. First, given the cross-sectional nature of our data, we are unable to make causal interpretations. Second, cervical cancer screening behaviors were assessed from the respondents' self-reports, which may cause bias. Third, measures of CCS in HINTS only considered the adoption of a pap test that could not fully demonstrate screening behavior. In general, HPV test can combine or replace the pap test to screen for cervical cancer. Further investigation data may be needed to characterize and evaluate the behavior of CCS. Even so, our study sheds light on the importance of further research.

Conclusion

In summary, this study aims to examine the health disparity in cervical cancer screening, and develop possible health promotion means to reduce health disparity as well as promote effective screening behavior. We obtain two findings. First, we found differences persists while cervical cancer screening rates increase year after year between active CCS and effective CCS. These differences are easily overlooked by providers and thus, could be the reason why CCS cannot be truly improved. Second, we found an intriguing evidence to understand the mechanisms of effective CCS, in which social network mediates effective screening behavior as an internet digital technology. This evidence could provide a new clue to the intervention plan of CCS.

Abbreviations

Health Belief Model (HBM)

Social Cognition Theory (SCT)

Cervical Cancer Screening (CCS)

National Cancer Institute (NCI)

the fifth National Cancer Institute's Health Information National Trends Survey (HINTS 5 Cycle 1)

Declarations

Ethics approval and consent to participate

This study uses second-hand data from the fifth National Cancer Institute's Health Information National Trends Survey (HINTS), which can be obtained publicly. HINTS was developed by the Health Communication and Informatics Research Branch (HCIRB) of the Division of Cancer Control and Population Sciences (DCCPS) as an outcome of the National Cancer Institute's Extraordinary Opportunity in Cancer Communications. <https://www.cancer.gov/>

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analysed during the current study are available in the [the fifth National Cancer Institute's Health Information National Trends Survey] repository, [<https://hints.cancer.gov/data/default.aspx>]

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Feiyang Zheng: Data Curation, Methodology, Writing-Original draft preparation, Software. Liqin Zhou: Conceptualization, Investigation. Xiang Wu: Writing- Reviewing and Editing, Funding acquisition. All authors read and approved the final manuscript.

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