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mHealth Pilot Study: Text Messaging Intervention to Promote HPV Vaccination

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Abstract

Objectives—To test the feasibility and efficacy of a culturally-tailored mobile health intervention designed to increase knowledge about, intent to obtain, and receipt of the HPV vaccine.

Methods—A 7-day text message HPV intervention was developed using a quasi-experimental research design for 30 Korean-American women.

Results—Participants demonstrated significant increases in knowledge of HPV with an intent to get vaccinated within one year, and 30% of participants received the first dose of the HPV vaccine.

Conclusions—Mobile health technology could be a promising tool in reducing the cancer burden for underserved populations.

Keywords

HPV; cervical cancer; text messaging; intervention; mobile phone; health disparity; Korean-American women

Asian-American women have higher cervical cancer incidence and mortality than their non-Latina White counterparts.^{1–4} At the same time, Asian-American women have a lower rate of human papillomavirus (HPV) vaccine uptake than non-Latina Whites.⁵ Given that the HPV vaccines, HPV2 (Cervarix) and HPV4 (Gardasil), are extremely effective tools for

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Human Subjects Statement

The University of Minnesota Institutional Review Board approved the research procedure for this study.

Conflict of Interest Statement

The authors declare no conflict of interest associated with this study or the publication of results.

reducing cervical cancer caused by HPV-16 and HPV-18, increasing HPV vaccination rates could significantly reduce the cancer burden in Asian-American women.^{6,7}

A growing body of research has begun to identify barriers and facilitators of HPV vaccination among female Asian-American immigrants.^{8–11} Data from the California Health Information Survey indicate that Asian-American immigrants are the least knowledgeable across racial/ethnic groups about HPV as the main cause of cervical cancer.^{5,12} Studies have also found that Asian women throughout the world have a low understanding of HPV vaccination.¹³ This lack of awareness about HPV vaccination persists when Asian women immigrate to the United States (U.S.).^{14–16} Other barriers to cancer control experienced by Asian women include cultural views on sexuality, as well as modesty and misconceptions about the prevention of HPV.^{14,16} Limited English proficiency, which is high among the Korean-American foreign-born population, has also been identified as a barrier to HPV vaccine uptake.¹²

Despite the importance of the HPV vaccine for cervical cancer prevention, intervention research for HPV vaccination promotion among this population is sparse. A recent literature review¹⁷ identified 14 intervention studies of females aged 18–26 (the group at highest risk for HPV infection), with only 5 having vaccine receipt as the primary outcome measure and only 8 including Asian Americans, who constituted just 2%–16.7% of the samples. The most frequently used education delivery method among these studies was an HPV fact sheet;^{18–24} other interventions were educational videos, online messages/blogs, information pamphlets, radio advertisements, and one-hour lessons/presentations on HPV and HPV vaccination.^{22,33} Research on HPV vaccination promotion specifically targeting Asian-American women is almost nonexistent. Furthermore, no single intervention has yet demonstrated superior efficacy that would warrant widespread implementation.¹⁷ As such, there remains a glaring need for research to identify successful intervention strategies for Asian-American women, especially using HPV vaccine receipt as the primary outcome.

Results from past limited health promotion efforts suggest that employing more culturally specific and personally tailored strategies could more persuasively encourage Asian-American women to use the HPV vaccine, and thereby decreasing this group's cancer health disparity.^{9,34–37} The current study focused specifically on Korean-American women, a population with one of the highest cervical cancer mortality rates across all racial/ethnic groups; incidence and mortality rates for cervical cancer are twice as high for Korean-American women as those for non-Latina White women.^{38–40}

Recognizing the urgent need to increase HPV vaccination in this population, the current study tested a mobile health (or mHealth) intervention with young Korean-American women (see Figure 1 for conceptual framework) guided by the Fogg Behavior Model (FBM).⁴¹ mHealth, an expanding field, has been defined as the transmission of information through mobile devices – for example, mobile phones, patient monitoring devices, and personal digital assistants – designed to support medical and public health care initiatives.⁴² Existing studies place mHealth as a promising tool for promoting health behavior change across a number of public health domains.^{43,44} Demonstrating broad applicability, mHealth has shown favorable behavior change outcomes in interventions for increasing the frequency of

blood glucose monitoring in adolescents with type 1-diabetes,⁴⁵ smoking cessation,⁴⁶ antiretroviral therapy in AIDS/HIV patients,⁴⁷ and obesity.¹¹ Specific to immunization intent, Stockwell and colleagues⁴⁸ found that children's immunization coverage improved when parents received individually-tailored reminder calls. The current study aims to test the feasibility and efficacy of a culturally and personally tailored mHealth intervention designed to: (1) improve knowledge, attitudes, and beliefs about cervical cancer prevention; (2) positively increase intent to undergo HPV vaccination; and (3) increase receipt of the HPV vaccine.

METHODS

Research Design and Data Collection

This research project focused on promoting both the Pap test and HPV vaccination through an mHealth intervention called *mScreening*. Findings presented here report on the HPV intervention only (results for the Pap test promotion have been published elsewhere).⁴⁹ This study utilized a pre-test/post-test, quasi-experimental research design. The eligibility criteria for study participants were: (1) being a Korean-American women aged 21 to 29; (2) living in Minnesota; (3) having no prior receipt of a HPV vaccine; (4) possessing valid health insurance; (5) having mobile phone access; and (6) having familiarity with or willingness to learn basic elements of text-based information communication technology. We used a multi-pronged recruitment strategy, consisting of brochures and flyers posted in churches, clinics, social service agencies, and ethnic grocery stores that serve the Korean-American population. We also advertised the study using public social media tailored toward the Korean-American population. We explained the purpose of the study, eligibility criteria, confidentiality, and the voluntary nature of participation in both oral and written formats to participants prior to obtaining their commitment. Thirty participants who met the inclusion criteria were enrolled and completed our intervention and data collection protocol. Four additional participants who were initially enrolled were subsequently determined to be ineligible because they had already received the first HPV shot in the vaccination series.

Intervention Development

We developed the contents of the mobile phone text messaging intervention using the community-based participatory research (CBPR) method. Through a series of focus groups with young Korean-American women and key informant interviews with Korean-American community leaders and health professionals, we determined that the best format to deliver the 7-day text-message-based intervention would be via mobile phone. The details of the CBPR method and the procedure for the focus groups have been reported elsewhere.⁴⁹

Directed by the Fogg Behavior Model,⁴¹ the mobile phone text messaging intervention, *mobile screening (mScreening)*, identifies barriers, develops motivators, and provides a trigger to initiate a health behavior action, such as receiving the HPV vaccine (see Figure 1 for conceptual framework). The content of the *mScreening* intervention was individually tailored for each participant and included: (1) basic health information about the cervix and cervical cancer, including statistical facts, such as cervical cancer incidence and mortality among Korean-American women compared to other racial/ethnic groups in the U.S.; (2)

introduction of the HPV vaccine as a preventive means against cervical cancer; (3) information about healthcare accessibility and availability of local clinics; (4) cost of HPV vaccination and information about how to use health insurance; (5) stories that described Korean-American women overcoming cultural barriers to vaccination; and (6) testimonials of cervical cancer survivors who had gone through HPV vaccination. Participants selected their preferred time for intervention delivery and messages were delivered according to those individual preferences. The *m*Screening intervention also contained a high level of interaction, using quizzes and questions. The 14 questions and quizzes delivered during the one-week intervention asked about participants' knowledge of cervical cancer mortality and screening rates. On the last day of the intervention period, we tested their knowledge to ascertain whether they had learned over the course of the intervention. Messages were tailored by providing culturally-relevant testimonies from peers about cervical cancer diagnosis and experiences with HPV vaccination, as well as offering clinic information near each participant.

We conducted a usability test with 8 focus group members. Based on the comments we received from focus group participants who completed the usability test, we modified the messages' content, tone, wording, and length. Once we modified the contents of the intervention accordingly, we then delivered the refined mobile phone text messaging intervention to 30 participants. The individually tailored messages were delivered to each participant for between 20–30 minutes per day for a 7-day period at each participant's preferred time. Because all participants were fluent in the English language, all messages were written in English.

Measures

We conducted a face-to-face interview for pre-, post-, and follow-up testing at each participant's preferred place using a paper-and-pencil questionnaire. We collected information from participants at 3 different time periods: study enrollment (baseline); one week after completing the mobile phone text messaging intervention (post-test); and 3 months after completing the study (follow-up test).

Outcome measures—The primary outcomes of interest included: (1) changes in knowledge, attitudes, and beliefs about cervical cancer and HPV vaccination; (2) intent to undergo HPV vaccination; and (3) receipt of the first dose of HPV vaccine.

Baseline measures—We collected participants' sociodemographic information (age, marital status, education, income, and employment status), health-related information (family cancer history, usual source of care, and health insurance), and level of acculturation (years in the U.S. and English language proficiency). We also collected information about knowledge and beliefs related to HPV and HPV vaccination, cultural health beliefs and attitudes, self-efficacy toward cervical cancer prevention and screening, and intent to receive the HPV vaccine as part of cervical cancer prevention. For knowledge about HPV and HPV vaccination, we adopted McPartland and colleagues'⁵⁰ 16-item scale. We used scales from Niederdepp and Levy⁵¹ to measure cultural health beliefs, such as fatalism, and a scale from Tang and colleagues³⁴ to measure modesty. For measuring self-efficacy for cervical cancer

prevention and screening, we used the 8-item scale of Fernández and colleagues.⁵² Sociocultural and personal barriers to cervical cancer prevention and screening were measured using the scale developed by Betancourt and colleagues.⁵³ Finally, intent to receive the HPV vaccine was measured according to the trans-theoretical model (ie, stages of change consisting of pre-contemplation, contemplation, preparation for action, action, and maintenance).⁵⁴ Appendix reports each scale's psychometric properties in pre- and post-test.

Post-test measures—At one-week post-intervention, we administered a post-test survey of the same items we collected at baseline. We also surveyed for general satisfaction with and recommendations about the mobile phone text messaging intervention to gain insight for quality assurance and improvement. At the 3-month follow-up interview, we asked participants if they had received a dose of the HPV vaccine and, if they had not, their reasons for that decision.

Data Analyses

Differences in constructs relating to knowledge, attitudes, and beliefs about HPV and the HPV vaccination from baseline to study completion were summarized by the mean and standard deviation and tested using the paired t-test. Two approaches for comparing the intent to receive the HPV vaccine pre- and post-intervention were considered. First, we translated the change in a participant's intent to receive the HPV vaccine to a numerical scale with participants receiving a 1 if their intent to receive the HPV vaccine increased, a 0 if their intent to receive the HPV vaccine stayed the same, and a -1 if their intent to receive the HPV vaccine decreased. We then summarized change in participant's intent to receive the HPV vaccine by examining the mean and standard deviation and compared the mean change to 0 using the one sample t-test to determine if, on average, participants' intent to receive the HPV vaccine increased from pre-intervention to post-intervention. In addition, we dichotomized intent-to-receive the HPV vaccine into "intent to receive within a year" and "no intent to receive within a year." The percent of participants providing each response before and after the intervention were compared using McNemar's test for paired binary data. We estimated the rate of receipt of the HPV vaccine post-intervention and at the 3-month follow-up using the sample proportion, and 95% confidence intervals were estimated using the exact method. Measures of acceptability and satisfaction were summarized using counts and sample proportions. Given the preliminary nature of the study and relatively small sample size, multivariate analyses were not conducted and only univariate results are reported.

RESULTS

Demographic Characteristics of the Sample

Study participants' baseline demographic information (N = 30) is presented in Table 1. Participants' ages ranged from 20–29 years, with a mean age of 23.5 (SD=2.6). Only 36.7% of participants reported living in the U.S. for 3 years or less; 90% reported living in the U.S. for less than 9 years. Almost all participants (93.3%) reported having health insurance. Half (50%) reported having a primary clinic and 20% reported having a primary physician. Almost two-thirds (63.3%) of the participants reported a family history of cancer.

Changes in Knowledge, Attitudes, and Beliefs

Table 2 presents pre-intervention to post-intervention changes in measures of knowledge, attitudes, and beliefs about HPV and HPV vaccination, personal barriers to cervical cancer prevention and screening, and self-efficacy toward cervical cancer prevention and screening. Significant differences were observed for knowledge about HPV and HPV vaccination ($p < .001$), personal barriers to cervical cancer prevention and screening ($p < .001$), culturally-based attitudes toward cervical cancer prevention and screening ($p = .005$), and self-efficacy toward cervical cancer prevention and screening ($p = .002$). No significant difference was observed for modesty ($p = .347$). All differences remained statistically significant after a conservative Bonferroni multiple comparison adjustment, which requires a p -value <less than 0.008 for statistical significance.

Intent and Receipt of HPV Vaccine

Table 3 presents study participants' intent to receive the HPV vaccine before and after the intervention program. We observed a statistically significant increase in participants' intent to receive the HPV vaccine (mean difference=0.47, 95% CI: 0.21, 0.72; $p < .001$). The percent of participants indicating intention to receive the HPV vaccine within one year increased (from 63.3% to 96.7%; $p = .009$). In addition, 16.7% of study participants reported receiving the first of the 3-shot series for the HPV vaccine one week after completing the intervention program. An additional 13.3% of participants reported receiving the first dose of the HPV vaccine by the 3-month follow-up visit, indicating that 30.0% of participants received the HPV vaccine (95% CI: 9.9%, 42.3%) following the intervention.

Acceptability and Feasibility of the Intervention

Table 4 presents participant responses to questions related to the acceptability and satisfaction of the 7-day text messaging intervention. At the 1-week post-test visit, 83.4% of participants reported being either "satisfied" or "very satisfied" with the intervention program. In addition, 100% of the participants indicated that their knowledge about HPV and HPV vaccination increased and 93.3% of participants indicated that they wanted to receive the HPV vaccine.

DISCUSSION

The current study demonstrated significant improvements in participants' knowledge about HPV and HPV vaccination, personal barriers to cervical cancer prevention and screening, cultural attitudes toward cervical cancer prevention and screening (fatalism), self-efficacy toward cervical cancer prevention and screening, and intent to receive the HPV vaccine, following a tailored *m*Screening intervention. Perhaps the most notable finding was that 30% of participants reported having received the HPV vaccine by the 3-month follow-up interview. This constitutes a significant achievement considering the intervention targeted a high-risk group that had not previously engaged in cancer prevention and screening activity. These findings suggest that mobile phone text messaging interventions can be effective tools for creating behavior change around cervical cancer prevention for previously hard-to-reach, underserved populations, such as young Korean-American women. This finding is in line with several other studies that suggest mHealth can be successfully employed for effecting

behavior change. For example, Khokar⁵⁵ found that using an SMS reminder system to target breast cancer screening rates significantly increased the practice of breast self-exam among participants. Additional interventions have been used in clinical healthcare for disease management of issues such as asthma,⁵⁶ hypertension,⁵⁷ and diabetes,^{45,58,59} the latter being one of the most active fields of mHealth research. The current study's results add to the growing body of research demonstrating the potential for mobile phone text messaging interventions to increase health literacy and promote health behavior change in at-risk populations. mHealth interventions are able to overcome barriers to participation in traditional face-to-face interventions, such as inconvenience, time/place of delivery, and cost. Although further research is needed, mHealth may prove to be an effective and efficient, low-cost tool for engaging with traditionally hard-to-reach populations, especially given the increasing penetration of mobile technology into all socioeconomic and demographic subpopulations.

The tailored format of the present *m*Screening intervention might partly explain the high acceptance rate of the intervention in our investigation. Tailoring included offering information about clinics near each participant and culturally relevant stories from immigrant peers about their HPV vaccination experiences. Several studies have demonstrated that interventions using culturally and personally tailored public health messages have greater success in achieving behavior change.^{59–62} Indeed, the ease of message tailoring and interactive messaging (which can be achieved through a smartphone mobile app) is an important advantage of mHealth interventions, likely to contribute to the success of future interventions. In addition, mHealth interventions can be readily tailored to reach populations with limited English proficiency. These populations are currently underserved, difficult-to-engage, and hard-to-reach through with current cancer control efforts.

Adding to their appeal, mobile phone interventions may be readily accepted because of the ubiquity of mobile phone ownership in the U.S. and the increase in using mobile technology to access health information. Recent research has found that 31% of cell phone users and 52% of smartphone users have accessed health information from their mobile devices, with evidence that younger, minority populations are most likely to use their cell phones to access health information.⁶³ These findings suggest that more research should be done to assess the potential for culturally and personally tailored interventions utilizing this technology to promote preventive health care among minority, at-risk populations.

Results of the current study indicate that the Fogg Behavior Model⁴¹ is useful in improving cervical cancer prevention behaviors. Guided by the model, we identified barriers to HPV vaccination and addressed cultural and structural factors (language limitations, knowledge of HPV and HPV vaccination), as well as individual factors (eg, family history of cancer) that inhibited cervical cancer prevention in Korean-American women. We directly addressed these barriers through the creation of tailored motivators and triggers for behavior change. In this way, the Fogg Behavior Model provided a framework for the development and execution of a mobile phone intervention designed to increase health literacy and promote change in health behavior.

This study had several limitations, indicating prime areas for future research. Our investigation was quasi-experimental, with a small number of participants and no control group to compare for intervention effects. Future research should employ a randomized controlled trial design with a larger sample of Korean-American women. Additionally, the study was not designed to investigate the optimal intervention length. Future investigations should compare the 7-day text message program with a shorter program (eg, 3 or 5 days) to determine the most effective intervention length. Efforts to determine optimal intervention length and mode of delivery will lead to the development of an intervention even more effective and efficient in promoting cervical cancer prevention, by ensuring participants' engagement and satisfaction. Delivering information through a text message program via mobile app, which would enable the use of a password function to enhance participants' confidentiality and privacy, should also be considered. Finally, although the HPV vaccine series involves 3 shots delivered over a 9-month period, the current investigation focused only on vaccination initiation. Because our study was not designed for a long-term follow-up period, it was not possible to determine if participants completed the series. Existing research has shown that minority groups, particularly African Americans, have a higher rate of initiating HPV vaccine, but a lower rate of completing the full series of shots.⁶⁴ Future research that expands on our mHealth intervention should build in reminder apps that motivate participants and address adherence barriers so that participants complete the vaccine series.

Despite these limitations, our investigation adds important information to the field of mHealth research by expanding existing knowledge of mHealth's impact on an underserved population group at increased risk for cervical cancer. As one of the first studies to test the acceptability, feasibility, and impact of a culturally and individually tailored mHealth intervention for cervical cancer prevention, this study provides compelling evidence of the potential for tailored mHealth interventions to decrease the cervical cancer disparity experienced by Korean-American women. Additionally, the methods and intervention delivery used in this study could easily be adapted to other ethnic groups, expanded to meet the needs of such underserved minority groups as Latina-, Hmong-, Vietnamese-, and African-American women. These groups encounter similar barriers to cervical cancer prevention and limited HPV vaccine uptake and have high levels of cervical cancer and cervical cancer-related mortality.^{65–67}

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Appendix: Cronbach's Alpha for Constructs Used in this Study

Construct	Pre-test	Post-test
Culture-based beliefs on cervical cancer: Fatalism	0.65	0.76
Culture-based attitude toward cervical cancer prevention: Modesty	0.61	0.85

Construct	Pre-test	Post-test
Knowledge about HPV and HPV vaccination	0.64	0.58
Self-efficacy toward cervical cancer prevention and screening	0.93	0.95
Personal barriers to cervical cancer prevention and screening	0.66	0.62

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Figure 1. Conceptual Framework of the Study

Note.

The conceptual framework of the study has been published elsewhere.⁴⁹

Table 1

Baseline Socio-demographic Characteristics of the Sample

Variable	Categories	Frequency	%
Age	20 – 22	11	36.7
	23 – 25	13	43.3
	26 – 29	6	20.0
Marital status	Married	1	3.3
	Other	29	96.7
Years in US	3 or less	11	36.7
	4 – 8	16	53.3
	9 or more	3	10.0
Employment	Yes	11	36.7
	No	19	63.3
Education	Graduated high school	19	63.3
	Graduated from college/university	9	30.0
	Graduated from graduate school	2	6.7
Monthly income	under \$499	14	48.3
	\$500 – \$999	7	24.1
	\$1000 – \$1499	3	10.3
	\$1500 or more	5	17.1
Health status	Poor	3	10.0
	Fair	16	53.3
	Good	6	20.0
	Very good or excellent	5	16.7
Living arrangement	Live alone	12	40.0
	Live with spouse only	1	3.3
	Live with others	17	56.7
Currently living in	Rented house or condominium	19	63.3
	Government subsidized Senior citizen apartment	4	13.3
	Unsubsidized apartment	3	10.0
	Rented room in other's home	3	10.0
	Other	1	3.3
Self-rated financial status	Very bad	1	3.3
	Bad	3	10.0
	Fair	20	66.7
	Good	4	13.3
	Very good	2	6.7

Variable	Categories	Frequency	%
How often do you work out per week?	Not at all	8	26.7
	Once	2	6.7
	Twice	11	36.7
	Three times	4	13.3
	Four times or more	5	16.6
Smoking status	Not at all	28	93.3
	Some days	1	3.3
	Every day	1	3.3
Alcohol consumption	Not at all	13	43.3
	Some days	17	56.7
	Every day	0	0
Health insurance	Yes	28	93.3
	No	2	6.7
Primary hospital	Yes	15	50.0
	No	15	50.0
Primary physician	Yes	6	20.0
	No	24	80.0
Family cancer history	Yes	19	63.3
	No	11	36.7

Changes in Knowledge, Attitudes, and Beliefs about HPV and the HPV Vaccination Comparing Pre- to Post-intervention (N = 30)

Table 2

Construct	Baseline pre-test		One-week post-test		Mean Difference	p value
	N	Mean (SD)	N	Mean (SD)		
Knowledge about HPV and HPV vaccination	30	0.71(0.13)	30	0.88(0.11)	0.17	< .001
Personal barriers to cervical cancer prevention and screening	20	0.48(0.23)	30	0.27(0.16)	-0.21	< .001
Culture-based beliefs on cervical cancer: Fatalism	30	1.55(0.56)	30	1.33(0.46)	-0.22	.005
Culture-based attitude toward cervical cancer prevention: Modesty	20	1.52(0.49)	30	1.43(0.55)	-0.09	.347
Self-efficacy toward cervical cancer prevention and screening	30	2.66(0.60)	30	2.99(0.50)	0.33	.002

Table 3
Study Participants, Intent to Receive HPV Vaccine before and after Intervention (N = 30)

Intent to Receive the HPV Vaccine						
One-week post-test						
No plans within 1 year	Within 1 year	Within 3 months	Within 1 month	Have received HPV vaccination	Total	
N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	
0 (0.0)	10 (33.3)	1 (3.3)	0 (0.0)	0 (0.0)	11 (36.7)	
1 (3.3)	5 (16.7)	0 (0.0)	1 (3.3)	2 (6.7)	9 (30.0)	
Baseline pre-test						
0 (0.0)	2 (6.7)	1 (3.3)	1 (3.3)	0 (0.0)	4 (13.4)	
0 (0.0)	0 (0.0)	0 (0.0)	3 (10.0)	2 (6.7)	5 (16.7)	
0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.3)	1 (3.3)	
1 (3.3)	17 (56.7)	2 (6.6)	5 (16.7)	5 (16.7)	30 (100)	

Table 4

Participants' Acceptability of and Satisfaction with Intervention Program: One-week Post-test Interview (N=30)

Question	Answer	Frequency	%
Please rate your satisfaction level with intervention program	Very satisfied	8	26.7
	Satisfied	17	56.7
	Neutral	5	16.7
	Dissatisfied	0	0.0
	Very dissatisfied	0	0.0
After the intervention program, do you think that your knowledge about HPV is increased?	Yes	30	100
	No	0	0
After the intervention program, would you like to receive the HPV vaccine?	Yes	28	93.3
	No	2	6.7