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Utilizing mHealth technology to increase HPV knowledge and HPV vaccine uptake in adolescents: A qualitative study

Gabrielle C. Darville

The University of Georgia, gabrielle.darville@uga.edu

Charkarra Anderson-Lewis

The University of Southern Mississippi, c.andersonlewis@ufl.edu

Rebeccah Mercado

The University of Florida, rebeccahmercado@ufl.edu

Jessica Ma

The University of Georgia, jma@uga.edu

Jann MacInnes

The University of Florida, jann@ad.ufl.edu

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Abstract

This study sought to identify communication preferences for tailoring mHealth interventions on HPV and what information in messaging should be included to increase HPV education, vaccination and schedule adherence among youth. A convenient sample of 210 students answered an online survey. Participants were 18–25 years old (88%), female (85.6%), Caucasian (60%), never been diagnosed with HPV (92.9%) and completed all three doses (61.6%). Our respondents were initially hesitant to use SMS text messages and mobile apps for HPV primarily due to privacy, memory and data cost concerns but thought the personalization options would increase message saliency and information trustworthiness if sent by a healthcare provider. Healthcare providers should use the information to tailor HPV and sexual health interventions.

Introduction

Human papillomavirus (HPV) infection is the most common sexually transmitted infection (STI) in the United States and is responsible for 99% of all cervical cancer cases worldwide (CDC, 2017; World Health Organization, 2010). Over 40 strains of this DNA virus are capable of infecting cutaneous and mucosal surfaces in the human genital tract through direct sexual contact, causing genital warts and various cancers (Braaten & Laufer, 2008; National Cancer Institute, 2015). Although a vaccine is available to reduce the risk of HPV infection, immunization coverage rates remain low worldwide. In the U.S., approximately 41.9% of females and 28.1% of males have attained complete adherence, while only 1.4% of the global female population has received a complete course of HPV vaccination (Bruni et al., 2016; Reagan-Steiner et al., 2016).

Current literature highlights the importance of the healthcare provider in increasing vaccine uptake by giving strong recommendations, communicating openly and informatively with patients and parents, and distributing reminders to patients who are due for vaccination based on recommended immunization schedules (Katz et al., 2010; Ventola, 2016). However, many healthcare providers drop the ball. Text messaging and smartphone applications (apps) present two areas for potential use. Both technologies are highly accessible and popular worldwide, and their usage is more evenly distributed across all divisions of race, class, and international borders compared to other devices and services such as desktop computers, laptop computers, and home broadband Internet (Bruni et al., 2016; Lim et al., 2008; Smith, 2017). Current literature indicates an uptake in the use of text messaging and apps as mobile health interventions, with evidence that these methods have succeeded in reducing missed appointments, educating adolescents about sexual health, and tracking patient information.

However, very little existing research has examined the application of these technologies specifically to HPV interventions aimed at increasing uptake and encouraging schedule adherence. Thus, further inquiry in this area is needed.

Literature Review

HPV Pathology & HPV Vaccination

Human papillomavirus (HPV) refers to a group of over 150 related types of a DNA tumor virus that causes abnormal growth and accumulation of epithelial tissue in skin and mucous membranes (Braaten & Laufer, 2008). More than 40 types of HPV infect the human genital tract and can be transmitted through direct sexual contact, including oral, vaginal, and anal sex. Each of these sexually transmitted types of HPV falls into one of two categories: non-oncogenic or low-risk strains can cause the formation of skin warts in the anogenital area, while oncogenic or high-risk strains can cause cervical, anal, oropharyngeal, vaginal, vulvar, and penile cancers (National Cancer Institute, 2015). HPV is responsible for approximately 90% of all cases of genital warts, 99% of all cervical cancers, 95% of all anal cancers, and 70% of all oropharyngeal cancers worldwide (National Cancer Institute, 2015; World Health Organization, 2010).

To reduce the risk of HPV infection and its potential health effects, the Centers for Disease Control and Prevention (CDC) recommends that all children ages 11 to 12 receive at least two doses of an HPV vaccine six to 12 months apart; however, vaccinations can start as early as nine years old. “Catch-up” vaccination is also recommended on a three-dose schedule for females up to age 26, males up to age 21, transgender adults up to age 26, and young adults with immunocompromising conditions such as HIV/AIDS up to age 26. Gardasil-9 (9vHPV) the most recent FDA approved vaccination includes protection from types 16, 18, 6, 11, 31, 33, 45, 52, and 58; 5 more strains than the previous Gardasil-4 (4vHPV) vaccine (Meites, Kempe, &

Markowitz, 2016). These strains are the ones most attributed to increasing rates of genital warts, cervical, oral, penile and anal cancer. In 2015, approximately 62.8% of females and 49.8% of males in the U.S. had received at least one dose of an HPV vaccine, with variances from state to state (Reagan-Steiner et al., 2016).

Vaccine Adherence & the Role of the Healthcare Provider

Vaccine adherence schedule and dosage completion by adolescents and young adults depend heavily on healthcare provider recommendations (Ventola, 2016). Healthcare providers can promote vaccine acceptance and adherence in two ways: (1) by disseminating information on HPV vaccination to adolescents and young adults as part of an educational campaign to influence both perceived HPV risk and vaccine effectiveness and (2) by developing strong relationships with patients and their guardians (Katz et al., 2010). Current literature suggests that communication between providers, patients, and parents is one of the most important factors influencing vaccine uptake. Evidence shows that “parental and patient education provided by primary care physicians can be particularly important in influencing higher vaccine uptake” (Ventola, 2016, p.433-434). With the increasing use of digital communication technologies such as mobile phones and SMS text messages, patient reminders could benefit healthcare providers and eligible patients to ensure adherence to the recommended HPV vaccination schedule.

Digital Communication Interventions for Vaccine Adherence

Short messaging service (SMS), also known as text messaging is used billions of times per year as a low-cost communication tool by most people. The technology is highly popular among young individuals, accessible in many developing countries and is equitable across all social gradients making it a promising tool for sexual health interventions (Lim et al., 2008). Benefits identified in a focus group study on sexual health highlighted the simplicity,

affordability, and privacy of the system as well as the informative content (Perry et al., 2012). Sexual health clinics that have adopted SMS for multiple purposes such as including appointment reminders, provision of STI test results, patient-provider exchanges, and contact tracing after STI diagnosis have shown positive results (Lim et al., 2008). Educational sexual health campaigns where SMS text messages have been utilized as a “question-and-answer service” in which users can anonymously seek information from healthcare providers have also shown success (Chib et al., 2012; Lim et al., 2014). Although text messages have also been shown to be effective in reducing missed appointments and are widely accepted and preferred by patients as a primary channel for reminders and other health-related communications (Lim et al., 2008); overall little research has been conducted exploring its impact on HPV vaccination uptake.

Mobile applications, or mobile apps, are “downloadable software products that run on mobile devices” and present another opportunity for the development of interventions for HPV vaccine adherence (Kratzke & Cox, 2012, p. 73). Approximately 88% of Americans use the Internet and 77% own smartphones, including 64% of low-income individuals earning less than \$30,000 per year (Smith, 2017; Kratzke & Cox, 2012). Many currently available health apps focus on behavioral health and change: patient self-assessment, home therapy practice, and the tracking of nutrition, water consumption, physical activity, and weight change are common functions of these products. Other apps allow users to easily access and navigate databases of clinical information as an efficient and reliable reference system; clinician-facing options such as *Psych Central* and *Epocrates* allow health care providers to access information regarding behavioral health and pharmaceuticals, respectively, while patient-facing options such as *DSM-IV-TR* and *ICD-10 Search* allow users to search for and learn about psychiatric conditions and

diagnoses (Kratzke & Cox, 2012). Very few applications that are currently available function primarily as interventions for recommended vaccinations. One literature review concluded that while text messaging and computerized reminders showed promise for increasing immunization coverage, there was inadequate evidence and information regarding the effect of smartphone applications on vaccine uptake (Odone et al., 2014). This gap in the literature underscores the necessity of increased research on the acceptability, development, and implementation of mobile applications as interventions for HPV vaccine uptake and adherence.

The purpose of this research study was multi-layered. We were not only interested in determining the pros and cons of using digital communication technologies for an HPV intervention, but wanted to identify what information should be included in an HPV intervention using SMS text message or a mobile app to increase vaccination rates among adolescents and young adults. Lastly, we were also interested in identifying how these messages should be framed by healthcare providers for use on these communication channels. Because of this, the research questions that guided this study were:

- R01: What are reasons in support of and against receiving SMS text messages on the HPV virus for adolescents and young adults?
- R02: What are reasons in support of and against receiving SMS text messages on the HPV vaccine for adolescents and young adults?
- R03: What additional information should be included in a SMS text message intervention to promote the HPV vaccine among adolescents?
- R04: How should HPV vaccine messages in a SMS text intervention be framed?
- R05: What are reasons in support of and against using a HPV and HPV vaccine mobile app for adolescents and young adults?

- R06: What additional information should be considered when developing a mobile app to promote the HPV vaccine among adolescents?

Methodology

Sample

The study was conducted among both males and female students at a large public university in Florida. Although the target population for most HPV interventions is adolescents, college students were selected as the study participants because of (a) increased usage of new media technologies such as smartphones, the Internet, social networking sites and digital games and (b) because of their identity (18–26 year olds) as the “catchup group” for HPV vaccination. These study participants are designated as the “catchup group” because they were outside of the 9–11 age range or were too old when initial recommendations for the HPV vaccine were initially made by the CDC’s Advisory Committee on Immunization Practices (ACIP; Couto et al., 2014). Therefore, their recent transition from adolescent to young adulthood, potential awareness of the HPV vaccine being students enrolled in health courses and HPV vaccination status made them ideal participants for this study. We felt as though their viewpoints could best guide interventions seeking to increase HPV vaccine uptake among adolescents aged 9–12 to ensure optimal efficacy and best immune response before first onset of sexual activity.

We collected qualitative data from undergraduate and graduate students (n=210) on how to customize technological intervention on the HPV virus and HPV vaccine. The majority of our participants were 18 – 25 years old (n=147; 88%), female (n=143; 85.6%) and White/Caucasian (n= 126; 60%). Additionally, our population was never diagnosed with HPV (n=182, 92.9%), had already completed the vaccine series (n=119, 62.3%), and had completed all three doses of the HPV vaccine (n=117; 61.6%).

Procedure

After Institutional Review Board approval, Faculty that taught undergraduate and graduate health courses were contacted via email for approval to recruit participants from their courses. Faculty forwarded a recruitment email to their students that included a link to the survey. The survey was implemented using online software and once consent was electronically obtained, participants were promoted to begin the survey. Participants were able to skip questions that they did not want to answer as well as stop at any time without repercussions. Data collection was conducted with a convenience sample and no incentives were provided.

Survey Instrument

Various validated and reliable scales were used to guide questions surrounding HPV risk perception, sexual history and behaviors and technology use (Donadiki et al., 2014; Duggan et al., 2015; Fontenot et al., 2014; Fox & Duggan, 2013a; Fox & Duggan, 2013b; Katz, Krieger, & Roberto, 2001; Marchand et al., 2012). Using these scales, researchers developed a 45-item questionnaire that was used among survey respondents. The survey also included qualitative open-ended questions to draw suggestions from students pertaining to how to customize digital health communication tools on the HPV virus and vaccine.

Data Analysis

Descriptive data was analyzed using SPSS to obtain frequencies and qualitative data counts. To account for missing data, valid percentages were reported. Using the opened ended questions and responses as a guide, a codebook was developed from thematic coding. To establish inter-reliability of emergent codes, two researchers independently coded the survey question responses and met to discuss the codes identified. All findings and any differences were

discussed until 100% agreement was achieved. Notable quotes were pulled from survey results to answer the key research questions and can be found in Appendix A.

Results

Our study provided a depth of qualitative information pertaining to how HPV virus and HPV vaccine interventions could utilize health communication technology. Participants provided qualitative information in support of and against using smartphones and SMS text messages as a communication channel. They gave great insight on what information is important for interventions focused on tailoring HPV information for adolescents and young adults. The total number of responses for the qualitative questions varied from question to question, however major frames emerged and were reported in a way to clearly answer each research question.

SMS text messages on the HPV Virus. Among all participants, 30% ($n=51$) indicated that they would be receptive to receiving text messages on the HPV virus. A few of the emerging themes that stood out included increased awareness/knowledge, personalization or tailoring of messages and the “extension of self” concept. The “extended self” occurs when external objects, possessions and identities become viewed as part of the “self” because of the power or control that can be forced upon them (Belk, 1988). Because their cell phone is always with them and seen as an extension of themselves, it is more idealistic as a channel than other communication channels. Other themes also included using the text messages as appointment/vaccine reminders and as a simple source of information because of the ability to receive fast and easy to read updates. As one respondent explained, *“I use my phone all the time, I get tons of information, coupons, etc. why should disease be any different?”*

Among all participants, 70% ($n =121$) overwhelmingly indicated they did not want to received text messages on the HPV virus. Students against HPV vaccine text messages indicated

that they were concerned about the trust and reliability of the information and being spammed constantly based upon the timing and frequency of the messages. As one respondent explained, *“I feel like that is a gateway to get other text messages about other things. Kinda like junk mail on your emails, it would be “junk texts” that would just get ignored.”* Students associated using SMS text messages for more personal reasons (such as socializing or having personal conversations) and not information seeking. They also saw the text messages as an unconventional source for health information and preferred to receive HPV information (a) from their doctor (b) from other communication channels such as a website or health magazine or (c) would rather do their own research on the topic (See Table 1).

SMS text messages on the HPV vaccine. When asked about receiving text messages relevant to the HPV vaccine, 24% of respondents ($n=41$) indicated that they would be open to receiving the messages. Similar themes in support of using text messages for communicating about the HPV virus emerged for communicating about the vaccine. Besides the simplicity of information and accessibility/ convenience of the technology, students indicated that it would be a great way to track their vaccine status, update vaccine recipients of newer information related to the Gardasil shot, and had an increased likelihood of being read compared to emails. As one respondent expressed, *“If there were new findings on the outcome of the vaccine, if there were new risks associated with the vaccine, or if a newer version of the vaccine was developed and suggested for use.”*

Seventy six percent ($n=131$) of respondents were against receiving information on the HPV vaccine over text SMS message. They indicated that they thought it was very impersonal way to receive health information and that they were concerned about costs associated to data and memory restrictions through their cellular plans. Additionally, one theme emerged

repetitively by several students indicated that they were uncomfortable or had privacy concerns. They feared that received HPV vaccine messages on their phone which would communicate the wrong message to their friends and peers about their sexual health. Because of this, they indicated that they preferred to receive this information directly from their doctor via email or phone call. *“I already received it. If there was something really important about the effects of the vaccine or something then I would like to be notified by phone call or email.”* (See Table 2).

HPV vaccine Information for a SMS text message intervention. Although previous data collected indicated that that the majority of participants were hesitant to receive HPV and HPV vaccine information over SMS text messages, 85% of our study participants suggested ideas on what additional information should be considered. They thought the messaging should address the effectiveness of the vaccine (n=78; 46%), their risk of acquiring HPV (n=69; 40%) and the safety of the vaccine (n=67; 37%). Other suggestions highlighted the importance for the intervention to be entertaining and personalized to the population of focus. Respondents were increasingly in favor of using personal testimonies from those with HPV, indicated the important of using infographics/visual imagery, suggested that more focus should be on men, and communicated that they would like information about statistics/ infection rates as a way to measure their own susceptibility to the disease. As one respondent highlighted, *“Statistics of how many students are affected by HPV each year, and how many cases remain undiagnosed and progress towards cancer. They need to know that as the amount of sexual partners’ increases their chances for getting HPV or any other STD for that matter increases as well.”* It was also important to provide information about the short and long term benefits of receiving the vaccine, consequences of not receiving the vaccine, and possible side effects / safety concerns so that

adolescents and young adults could do their own risk vs. benefit analysis towards initiating vaccine uptake (See Table 3).

Framing of HPV Vaccine SMS text messages .The way in which the communication message was framed also proved to be an important aspect for students. They highly encouraged that the intervention not only focus on HPV, but explore all STD information so that recipients could get a comprehensive overview of information related to their sexual health. They also thought messages should include information relevant to vaccine initiation and completion (such as time required for appointments, providers/ locations that administer the vaccine, free/low cost options and how to maintain privacy if on parents' insurance plan). Examples of possible messages suggested by respondents are:

- **Participant 1:** *“HPV is very dangerous, however getting the vaccine is very easy and takes 5 minutes. In your current location, you can get the HPV vaccine in 3 different places in a 5-mile radius. In that radius 200 people got vaccinated in the last hour.”*
- **Participant 2:** *“Want to protect yourself from a disease that can be prevented with a simple vaccine? Learn more about HPV at www.HPV.com.”*
- **Participant 3:** *“Did you know that 75% of individuals who aren't vaccinated contract the HPV virus without sexual contact? The HPV vaccine is an easy 3 step- process.”*

Students thought it was important to allow recipients the ability to opt in/ opt out and highly valued getting the information from a credible source such as a reputable governmental health organization or healthcare provider (See Table 3).

HPV & HPV Vaccine Mobile Application. Although only 35% (n=59) of our respondents were open to a mobile application, they did provide substantial reasons healthcare providers should consider when exploring the development of a mobile app. An app proved to be more convenient to students: *“Apps are convenient. As lazy as this sounds, it would be a lot easier to have that information readily available to me rather than me having to search it on the*

internet. I would be much more inclined to read that information.” The increased flexibility of checking at your own leisure and setting an alert/ notification schedule that best met their own needs also made it advantageous. Therefore, they preferred it when compared to text messages that could be more annoying due to the timing and frequency of the messages. Overall, they saw the mobile app as a highly customizable communication channel by which to provide resourceful and relevant source of information.

Overwhelmingly, 65% (n= 110) of our sample was hesitant of the idea of using a mobile app to educate, inform and motivate one to receive the HPV vaccine. Apart from some of the similar expressed against a SMS text message intervention, students indicated that they primarily used their apps for other functions (social media), did not use health apps overall, and if they did they preferred health apps like those used for physical activity and fitness tracking. As one respondent explained, *“My phone on has a limited amount of space and data. I would prefer to use it for different reasons such as music, pictures, social media apps and game apps.”* A few respondents indicated that they lacked smartphone technology and for those who did have smartphones they said if the app had the words “HPV” or an HPV icon it could potentially be an embarrassing situation if the phone is lost or placed in the wrong hands (See Table 4).

HPV vaccine Information for a Mobile Application Intervention. They were also asked for additional suggestions for a health-related app on HPV and the HPV vaccine as seen in Table 5. Nearly 103 qualitative responses were collected pertaining to this question representing 49% of our sample. While the discussion or HPV can be a serious topic, respondents indicated that they wanted the app to be not only informative but entertaining/ interesting to use as well. They suggested that the app be free, updated frequently, incorporate great design to increase appeal for intended user and utilize a user-friendly interface. They thought that the app should be

interactive in nature, and allow for a variety of features such as forums/ chat rooms, embedded games, rewards/badges/ incentives, incorporate push notification, and include additional resources such as links to websites.

- **Participant 1:** *“Include a way to connect to the university and set up a doctor’s appointment online. Maybe chat with a physician option to save time on less serious issues and to ask questions.”*
- **Participant 2:** *“It wouldn’t have to be well advertised. People use apps for recreation, not education. It would be better off as a school or medical sponsored app to give it credibility and a reason to get it. Use it as a free promo like Starbucks does for apps to gain popularity.”*

Respondents also emphasized having the app log in features incorporate privacy safeguards such as anonymity (i.e. not having to sign up, register or link accounts such Facebook to it). Lastly, they also highly encouraged creative advertising and endorsement to increase credibility and usability among the target population (See Table 5).

Discussion

Although health communication technology is becoming more and more prevalent among adolescents and young adults, few studies have explored the feasibility of using mHealth technology to address sexual health and specifically HPV. Our study identified reasons in support of and against using SMS text message and mobile apps to communicate about the HPV virus and HPV vaccine and how information should be framed for the target population.

Although many of our study participants were against using SMS text messages due to possible privacy concerns, the spamming nature of text messages, and questionable reliability of the sender; reasons in support see text messages as a convenient way to provide relevant updates especially if sent by a healthcare provider or governmental health organization. Comparatively, students were more in favor of using a mobile app than text messages because of the personalization and customization opportunities of the technology. They expressed ideas in

support of an app that provided a comprehensive STD approach and utilized interactive features such as in app chats/ forums, embedded games, rewards and additional informative links. In order to increase use of the mobile apps among adolescent and young adults, participants expressed that the app shouldn't be labeled with an HPV icon or wording, should provide anonymity and should be developed in mind for those who may have data or memory restrictions.

According to several studies, healthcare in the United States has been shifting and moving towards utilization of mHealth technologies to improve practice efficiencies, provide health information and communicate with patients, all in an effort to improve health outcomes. Interestingly, medical professionals have been some of the earliest adopters of mobile technology for their practice and have begun using this technology to improve care (Luxton et al., 2011). Because mobile health (m-health) applications are being utilized by many clinicians and healthcare providers, patients are increasingly accessing their health information and actively engaging in their own healthcare through their smartphone (Boulos et al., 2011). (p.11). The advanced technology and extensive features associated with mobile technology make the utilization of mobile phone delivery for STD and specifically HPV prevention a feasible, acceptable and optimal option for health consumers and healthcare providers (Swendeman & Rotheram-Borus, 2010). Furthermore, also we know that health consumers want information that will be instantaneous, assisting them in making quick informed health decisions; decisions that take longer when utilizing the Internet for information (Kratzke & Cox, 2012).

We have already seen some successes with sexual health education programs and interventions utilizing technology to reach young patients. According to innovative sexual health promotion initiatives, daily web and mobile application technology use among youth, provides

endless opportunities to promote sexual health, prevent disease transmission and encourage behavior change (Allison et al., 2012). Furthermore, studies in public health that have utilized mobile text messages on sexual health have had wide acceptability by young people (Lim et al., 2014). And although there have been no sexual health mobile app interventions or studies conducted to date (Free et al., 2013), employing mobile applications shows promise as they can be integrated easily into traditional healthcare practice and offer increased ability for customization such as GPS location, in app chats or forums and increased accessibility features. The end – user – customization that smartphone apps allow for, such as in app avatars or characters, accessibility features for persons with disabilities and varying experiences or content tailored to the specific user, can increase usage patterns among intended audiences (Luxton et al., 2011).

Despite the cons associated with SMS text messages and mobile apps, students in our study expressed creative ways on how to develop the best mHealth technology intervention to benefit adolescents and young adults. Taking all of these suggestions as “lessons learned” healthcare practitioners and medical providers should think of creative ways using the suggestions to meet their most at risk population using the communication channels that they prefer.

Limitations

Although our study was instrumental in gathering their feedback concerning what healthcare providers and clinicians should take into consideration when developing technology based interventions such as SMS text messages and mobile apps on HPV, there were several limitations to our study including the qualitative nature. In qualitative studies, researcher personal bias can affect how the questions and responses are analyzed. Researchers of this study

are overwhelmingly in support of healthcare providers exploring the use of mHealth technology to communicate about HPV, despite the reasons offered up by the participants against its use because it's never been explored. Qualitative studies are also often hard to duplicate due to many interpretive models or methods used to analyze the information. Because of this, many see qualitative studies as possessing less rigor.

Secondly, the bias of enrollees could be seen as a limitation. The students that participated in our study were students in a health class which means they may have been more knowledgeable of HPV and sexual health issues than other adolescents and young adults. Because of this they may also be more likely to seek health information from the Internet than their peers who may lack the drive to do so. Additionally, more than 75% of participants in our study were females which resulted in limited input from males on their preferences when communicating about the HPV and HPV vaccine. Future studies should explore male's preferences for sexual health interventions utilizing technology.

Lastly, although our focus of this research study was to collect qualitative information on how clinicians can encourage HPV vaccine uptake among adolescents, we conducted this study with college students. This could also be seen as a limitation; however, we see it as an advantage. Research has shown that among adolescence, sexual risk behaviors often increase in late adolescence and early adulthood (Moilanen et al., 2010). Because the majority of our study sample were in the early adulthood stage, we felt as though their opinions would be most ideal for developing interventions as they were not too far removed from late adolescence phase. Our study sample were also very forth-willing to provide their own perspectives and incorporate thoughts from their peers adding to the richness in the data obtained. Additionally, because they were students enrolled in health education courses that may have taught public health strategies

such as program planning and patient health education they were able to provide creative strategies concerning technology interventions targeting adolescents.

Future Implications & Contribution

While there have been several research studies in the sexual health have explored using technology for sexual health interventions, none have explored HPV exclusively from a qualitative perspective and none have gathered information about the opportunities of using a SMS and a mobile app for HPV to inform healthcare providers. Although there were many pros and cons associated with using mHealth technology for HPV, adolescents and young adults speak technology. And with the increase of new media, there are opportunities to use the technology to answer their sexual health questions. This increasing trend is not only due to the failing sex education curriculum of our schools but also the lack of communication between healthcare providers and their young patients. According to the CDC, more than 50% of teens are not getting the information they need regarding sexuality, birth control, STD & HIV prevention, and unplanned pregnancy from current schools leaving them at a disadvantage (Quinn, 2016). Furthermore, doctors and healthcare providers are not who adolescents and young adults initially seek out for health information. In a report on *Teens, Health and Technology: A National Survey* only 29% of teens report getting “a lot” of health information from their providers and 40% report getting “some” health information from their providers (Waertella, 2016). Adolescents and young adults indicate that they prefer to get their information from their parents or do their own research using the internet which is also evident from the qualitative data obtained in our research (Lim et al., 2014; Waertella et al., 2015). However, both of these sources can also prove to be disadvantageous when discussing the human papillomavirus (HPV).

Although HPV has been linked to several cancers among both women and men and the HPV vaccine has been framed as cancer prevention vaccine, parents are still reluctant to have their adolescence receive the vaccine because of the sexual promiscuity connotation associated with it (Forster et al., 2010). This indicates that parental hesitancy can impact HPV vaccine perceptions and uptake behavior among adolescence and young adults. Additionally, it has been shown in research that although teenagers possess the digital literacy to access and navigate the internet, their knowledge of HPV can be limited by their searching behaviors. Research indicates adolescents tend to reference the top nine search results when using online search engines. This behavior not only impacts the answers they receive for health related questions but can affect their navigation techniques utilized when searching for health information over the Internet (Wartella et al., 2016).

One way that we can overcome these barriers is through healthcare provider education and recommendation through direct communication. However, many healthcare providers find it a challenge to discuss HPV and the vaccine with their adolescent patients because of time constraints to discuss both the risks and benefits, uncomfortableness in discussing sexuality with younger patients and inability to identify their information and communication needs (Zimet et al., 2013). Because of this, we have seen HPV vaccination rates hover around 65% for girls and 56% for boys with limited percentage point increases from year to year (Wappes, 2017).

Although newest HPV recommendations from the CDC have pushed for 2 dose series completion uptake among the adolescent age group if they initiate the HPV vaccine before their 15th birthday, the recommendations are not mandated leaving the discretion to discuss the complexity of the HPV virus/ HPV vaccine narrative up to the individual healthcare provider (Wappes, 2017). Therefore, if the healthcare provider doesn't recommend it and the parent

doesn't inquire about it then the adolescent does not get vaccinated for HPV. This is unfortunate as adolescent patients have higher sexual health risks and are more likely to forego healthcare and treatment due to barriers such as cost, insurance status and confidentiality issues. Lack of awareness about places to get sexual and reproductive healthcare free from parental input, waiting room time, and specific characteristics of their healthcare provider are other factors that may also cause discord or uncomfortableness in seeking information about and receiving the HPV vaccine (Perry et al., 2012). Taking all of this into consideration, healthcare providers should explore customizing their already existing technology practices (mobile apps and SMS text messages) to offer an alternative way to communicate with and connect with their young patients concerning the HPV vaccine. The information provided in this study can guide the creation of new mHealth strategies aimed at increasing HPV vaccine rates, diminish the uncomfortableness adolescents experience when discussing their sexual health with their healthcare provider and empower adolescents in their informed decision making skills regarding their health.

Conclusion

mHealth possesses the ability to be used for text messaging, appointment reminders, test results, health education messages, question and answer services, behavioral intervention delivery, direct provision of care, patient monitoring, and collection of community healthcare data. (Swendenman & Rotheram-Borus, 2010; Weinstein et al., 2014). Because of these reasons, it is suggested that mobile health technology will be the driver of telehealth and telemedicine, and by 2020 nearly 25% of patient and health care provider interaction will be done using mobile health (mhealth), using smartphones or smart wrist watches (Weinstein et al., 2014). Apart from sexual health interventions, we have also seen a rise in clinic care delivery for sexual health

using mobile health technology (Allison et al., 2012; Gold et al., 2010). Although the HPV vaccine has steadily increased in the last few years among males and females, uptake is still generally low (Nelson, 2014). Research has shown that when a health provider recommends the HPV vaccine, it positively impacts the adolescent's decision to receive the vaccine even when parental hesitancy may prove to be a barrier. (National Vaccine Advisory Committee, 2015). To ensure increased HPV vaccination rates even more, we encourage clinicians and healthcare providers to utilize the information presented to create effective mHealth communication strategies.

Appendix A

Table 1. Notable Quotes - Reasons in support of and against receiving SMS text messages on the HPV virus

Reasons in support of receiving SMS text messages	Reasons against receiving SMS text messages
<i>“I would be interested in receiving messages because it will keep me updated on the disease and spread of it”</i>	<i>“I use my text messaging for keeping connections. I would rather do my own research or have it sent to my email”</i>
<i>“It would be convenient to receive texts... I feel it could be more personalized as well.”</i>	<i>“I don’t think it’s necessary that I receive a text message about a disease, if it were that important I would rather a phone call from my doctor. Text messages are very impersonal.”</i>
<i>“I think it’s a great way to get the info. It is simple and not time consuming to read a text.”</i>	<i>“I feel like that is a gateway to get other text messages about other things. Kinda like junk mail on your emails, it would be “junk texts” that would just get ignored.</i>
<i>“I use my phone all the time, I get tons of information, coupons, etc. Why should disease be any different?”</i>	<i>“My text messages I prefer to be used for communication between family and friends, not use for information.</i>
<i>“It is very accessible. I have my cell phone on me all the time.”</i>	<i>“It’s not a major issue for me since I choose to stay abstinent.... If someone I knew were to see it on my phone it would give them the wrong impression about my sexual activity.”</i>

Table 2. Notable Quotes - Reasons in support of and against receiving SMS text messages on the HPV vaccine

Reasons in support of receiving SMS text messages	Reasons against receiving SMS text messages
<i>“To help with reminders to get the vaccine or appointment reminders.”</i>	<i>“I’m not that into receiving text updates on anything. I only use text for conversations.”</i>
<i>“If there were new findings on the outcome of the vaccine, if there were new risks associated with the vaccine, or if a newer version of the vaccine was developed and suggested for use.”</i>	<i>“I would not know whether to trust its reliability or not. Rather, I would be apprehensive to trust it.”</i>
<i>“It would be useful information, and my texts are private information, so no one would see them and question if I have HPV”</i>	<i>“I would rather access info at an appropriate time and not random text messages.”</i>
<i>“Helps keep people informed of health related information that they may not already know.</i>	<i>“I already received it. If there was something really important about the effects of the vaccine or something, then I would like to be notified by phone call or email.”</i>
<i>“It would be more comfortable than getting that information from a doctor.”</i>	<i>“I would rather receive the information from the internet or health professionals.”</i>

Table 3. Notable Quotes - Additional information to include in a SMS text message intervention & how to frame messaging

Additional Information to Include	Framing SMS Messaging
<i>“How to get the vaccine if you parents don’t approve and you are on your parent’s insurance.”</i>	<i>“Want to protect yourself from a disease that can be prevented with a simple vaccine? Learn more about HPV at www.HPV.com.”</i>
<i>“Risk factors, pictures, in depth information on how the vaccine could help.”</i>	<i>“Cute infographic that is easy to understand and isn’t a novel.”</i>
<i>“Personal testimonies of people with HPV and info on why men should get the vaccine.”</i>	<i>“I think it should be framed with personal stories to make it stick.”</i>
<i>“How many people that day got vaccinated compared to how many people got diagnosed with HPV and how easy it is to do.”</i>	<i>“I don’t feel that HPV should be the focal point. If you want to talk about STD prevention, you should do all STDs.”</i>
<i>“Reasons why we should get it, what HPV is exactly, negative outcomes of not getting the vaccine and side effects of HPV.”</i>	<i>“Did you know that 75% of individuals who aren’t HPV vaccinated contract the HPV virus without sexual contact? The HPV vaccine is an easy 3 step –process.”</i>
<i>“Statistics that make them realize their vulnerability to contracting HPV and the simple steps to prevent it.”</i>	<i>“Promote getting the vaccine by directly incentivizing it, like after the first shot you get a coupon for a free pizza. After the second you get a T-shirt. After the third you get tickets to a school sporting event.”</i>
<i>“Who can be contacted for further information or speaking with someone about my own personal questions, and it being not disclosed.”</i>	<i>“I think the messages should be supplemental to other reminders or texts on that person’s phone. For example, if a person receives a reminder text to work out that day, add an HPV note or story reminding the person why he or she should receive the vaccine.”</i>
<i>“Statistics of how many students are affected by HPV each year, and how many cases remain undiagnosed and progress towards cancer. They need to know that as the amount of sexual partners increases, their chances for getting HPV or any other STD for that matter increases as well.”</i>	<i>“HPV is very dangerous, however getting the vaccine is very easy and takes 5 minutes. In your current location, you can get the HPV vaccine in 3 different places in a 5-mile radius. In that radius 200 people got vaccinated in the last hour”</i>
<i>“If the information is conveyed in a culturally relevant context, it will be received well. For example, there are birth control reminder SMS text services that send women fun facts with their reminder to take birth control at a certain time every day. I think this could be effective for HPV info a well. If the text is limited strictly to medical information, people will not be interested. But if they receive a funny fact or joke with their text, they will have more positive perception of the information”</i>	<i>“I believe that an approach similar to Tobacco Free Florida would be effective. Canada made it mandatory to put disturbing images on cigarette boxes and in a year 38% of people named those images as a motivator to quit, so I believe a picture of what HPV could endure would obtain people’s attention enough to read the content of the message. BUT the picture should not be graphic and R-rated rather an internal photograph of cervical cancer maybe.”</i>

Table 4. Notable Quotes - Reasons in support of and against using a mobile app on the HPV virus and HPV vaccine

Reasons in support of using a mobile app	Reasons against using a mobile app
<i>"I use apps all the time on my phone, it might be more helpful than using text messages because that could get a little annoying."</i>	<i>"My phone on has a limited amount of space and data. I would prefer to use it for different reasons such as music, pictures, social media apps and game apps."</i>
<i>"Apps are convenient. As lazy as this sounds, it would be a lot easier to have that information readily available to me rather than me having to search it on the internet. I would be much more inclined to read that information."</i>	<i>"I think the information is important – but I would not use it if I had to log in or have an account that I had to link to like Facebook or something like that. It would need to be anonymous."</i>
<i>"An app would be more appropriate because you can use and check it at your own time and it could send out alerts or reminders if anything new is posted."</i>	<i>"I only use apps to track my activities instead of to inform me. I use the internet to be informed."</i>
<i>"If it encompassed multiple diseases than this would be better than just one."</i>	<i>"Because if your phone gets lost or a friend, especially of the opposite sex is borrowing your phone, that can be a potentially embarrassing situation."</i>
<i>"It would keep me informed and allow me easy access to the information."</i>	<i>"Just not something that would seem fun or recreational for our current culture."</i>

Table 5. Notable Quotes - Additional suggestions for a mobile app on the HPV virus and HPV vaccine

Additional components or features to consider when designing a HPV and HPV vaccine mobile app	
<i>"HPV knowledge quizzes, risk factor quizzes."</i>	<i>Being anonymous and not having to sign up or register for anything.</i>
<i>"The app should be more than just HPV, promote getting tested for STIs."</i>	<i>"To add as much humor and college lingo as possible, attract the student body."</i>
<i>"Adding other disease as well. Including a forum where students can anonymously post about their experiences."</i>	<i>"Include a way to connect to the university and set up a doctor's appointment online. Maybe chat with a physician option to save time on less serious issues and to ask questions."</i>
<i>"It wouldn't have to be well advertised. People use apps for recreation, not education. It would be better off as a school or medical sponsored app to give it credibility and a reason to get it. Use it as a free promo like Starbucks does for apps to gain popularity."</i>	<i>"Perhaps on the opening screen of the app, have a meter that shows the number of cases of HPV on the college campus. It would be unnerving to see that number go up, and I think it would keep students coming back to the app."</i>
<i>"I would make the app disguised as something else or vague from the title and cover screen of the app, so that anyone who passes by it on a phone can't tell what it is without opening the app first."</i>	<i>"I think the app should be made in a "fun" way. For example, there could be games included in it to make it more user-friendly"</i>

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