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Developing a Bilingual, Computer-Tailored, HPV Vaccination Promotion Intervention Targeting Latino Parents

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ABSTRACT

In this paper we present an innovative, computer-tailored application aimed at increasing Latino parents' intention to vaccinate their adolescent children against Human Papilloma Virus (HPV). HPV infection is the most common sexually transmitted infection in the United States. Latinas have the highest age-adjusted incidence rate for HPV-associated cervical cancer compared with their counterparts in other racial/ethnic groups. HPV vaccines offer hope against HPV-associated diseases. Because parental consent is required for children under age 18 to receive the HPV vaccination in most U. S. states, parents' attitudes and intention to have their children vaccinated are keys for promoting HPV vaccination. As health care providers often find it challenging to provide HPV vaccination education in clinical settings due to competing demands, we developed a computer-tailored application as an innovative and feasible approach to address this gap. The preliminary data suggest that our design is promising for increasing Latino parents' intention to vaccinate their adolescent children. In this paper we will provide the design of the application, preliminary findings and future plans.

Categories and Subject Descriptors

D.2.2 [**Software Engineering**]: Design Tools and Techniques – *decision tables, state diagrams, and user interfaces.*

General Terms

Design, Human Factors, Verification.

Keywords

Tailored Intervention, Mobile Application, HPV Vaccination

1. INTRODUCTION

HPV infection is the most common sexually transmitted infection in the United States; the infection rate is as high as 50% in sexually active individuals under age of 25 [1], highlighting the significance of this health problem. Annual healthcare costs related to HPV infections are about $1.7 billion [2], similar to the direct medical costs associated with HIV infection among individuals aged 15-24 years old [3]. For females, HPV is highly associated with cervical cancer; over 70% of cervical cancer is caused by infection with HPV types 16 and 18 [4]. For males, HPV can cause genital warts and head/neck, penile, and anal cancer. Male HPV infection also increases the risk of HPV infection in their female sexual partners [5]. Besides morbidity and mortality attributed to HPV-associated cancers, HPV infection is also associated with negative psychosocial outcomes (e.g., anger, fear) in HPV-positive women [6]. Given the health and economic burden of HPV infection, the need to address this public health issue through vigorous prevention efforts, including HPV vaccination, becomes clear.

HPV vaccines are efficacious in preventing HPV-associated cancers and diseases, and the Centers for Disease Control and Prevention [CDC] recommends that they be part of the routine vaccinations of both boys and girls at age 11 or 12 years [7]. Latinos have higher rates of HPV associated cancers than their counterparts in other racial/ethnic groups [8], [9], however, the vaccination rate in Latino adolescents remain low.

Unprecedented advances in information technology provide new avenues to create individualized health interventions in a more confidential, sensitive, accessible, and engaging manner. Research shows the effectiveness of a number of computer-based educational interventions related to health such as cancer screening [10], [11], decision making in cancer treatment [12], [13], healthcare services use among individuals newly diagnosed with cancer [14], and HIV/STI prevention [15]. Furthermore, research (e.g., [16], [17]) has demonstrated that computer-based educational interventions with tailored messages that target specific populations and personally adapted feedback about an individual's current health behaviors and beliefs can be effective in motivating the individual to change or maintain behaviors. Our application "We Care" shows promise to increase Latino parents' intention to vaccinate their adolescent children against HPV via linguistically and culturally relevant messages tailored to their specific needs. The major contribution of this paper is to describe the process and considerations in designing a cost- effective application to promote HPV vaccination in an at-risk population.

2. RELATED WORK AND SIGNIFICANCE

Several factors have been identified as associated with low HPV vaccination rates in Latino adolescents. Latino parents have been found to be significantly less likely than white parents to be aware of HPV vaccines ([18]. HPV vaccines are relatively new, and

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parents have concerns regarding their effectiveness and safety [19], [20]. Confusion about the link between HPV and cervical cancer, a lack of knowledge about the vaccine itself, and concerns that the vaccination may encourage early sexual behavior also influence Latino parents' willingness to consent their children to receive HPV vaccines [20], [21]. Other identified barriers to receiving HPV vaccines include a lack of health insurance, poverty, language and acculturation issues, and limited access to healthcare [20], [21], [22]. Of the few existing HPV vaccination promotion interventions targeting children and adolescents, most of them have focused only on girls [23], [24], [25]; half of them did not include vaccine uptake as an outcome [23], [24]; and only one study targeted the Latino population [24].

Computer-based health education delivers information that can be tailored to individual risk factors or diagnoses, is self-paced, and is considered more relevant by patients [17]. Touch screen and interactive computer programs are supported as practical, private, and user-friendly methods of collecting health-related data and delivering education [17], [26], [27]. Kreuter et al. [28] defined tailored interventions as "any combination of information or change strategies intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and derived from an individual assessment" (p. 277). Using tailored messages in computer-based health education can provide personally adapted feedback about an individual's current health behaviors, factors associated with the behaviors, and suggestions to motivate the individual to change or maintain behavior [17]. Thus, individuals who receive tailored information are more likely to remember the customized messages, which may lead to desired behavioral change [15].

Tailored interventions have been shown to be more efficacious than non-tailored ones [15], [16], [26], [29], [30]. Research also suggests that (1) an education tailored on 4-5 theoretical concepts is more effective than tailoring on fewer concepts; (2) tailoring on attributes such as beliefs/attitudes is associated with the largest effect sizes; and (3) tailoring to demographic characteristics such as age, gender, and race/ethnicity in addition to the behavior of interest may further enhance the effectiveness of theoretically tailored interventions [30]. Computer-tailored health education shows high a potential to change an individual's knowledge, attitudes/beliefs, and ultimately healthy behaviors and can be delivered in clinic settings when having discussions about health may be most relevant. To our knowledge, this is the first bilingual, computer- tailored health education program designed for Latino parents to increase HPV vaccination rates among their adolescent boys and girls.

The primary aims of this pilot study are to (1) develop a bilingual, computer-tailored health education program for Latino parents of adolescent children aged 11-17; (2) examine feasibility and acceptability of the health education program; (3) investigate the preliminary efficacy of the health education program on parental intention to vaccinate their children against HPV. The long-term goal is to conduct a rigorous, randomized controlled trial (RCT) to examine its efficacy. A successful health education of this nature also has the potential to have a positive impact on HPV vaccination among other populations. Furthermore, the findings will extend the science in using innovative computer technology to reduce racial and ethnic disparities in the incidence of HPV-associated cancers. This paper presents the first phase of this series of research.

3. DESIGN METHODOLOGY

The Precede-Proceed Model (PPM) [31] provides the basis for developing tailored messages in our health education program. According to Phase 4 of the PPM, which deals with individual behavior change, predisposing factors are defined as factors that are antecedents to the behavior change, while enabling factors act as external resources that facilitate behavior change [32]. We also integrate constructs from health beliefs model [33] and the theory of planned behavior [34], which are known to influence HPV vaccination behavior [36], [37], into a conceptual framework for our health education development (Fig.1). Our health education program includes tailored messages to address each of the predisposing factors (knowledge, perceived risk, facilitators, barriers, cultural beliefs), which would increase Latino parents' intention to vaccinate their adolescent children.

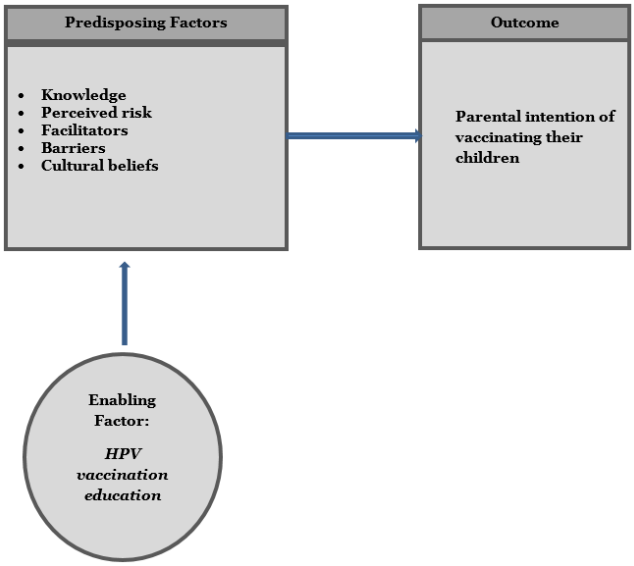

Figure 1. Conceptual framework

Table 1 gives an example of the tailored messages and corresponding constructs that might appear on the touchscreen for a 36-year-old mother who has an 11-year-old son.

Table 1.

Participant Response	Predisposing Factor	Sample Message
Relationship with the child = Mother Parent's age = 36 Child's gender = Male Child's age = 11 (demographic of the target parent and the child)	Knowledge	Your son just turned 11. Many parents do not think their adolescent children are at risk for human papillomavirus (also called HPV) infection because they do not see any symptoms. However, do you know that many adolescents who become infected with HPV do not even know they have it?

Table 1 Continued.		
I don't want my son to be vaccinated because it may encourage him to practice sex at this age	Barrier	Research findings do not show any relationship between getting HPV vaccination and sexual behavior in adolescents. In fact, the HPV vaccination protects your child from getting HPV and reducing his risk of developing genital warts and other HPV-related cancers.
If I know where to take my child for HPV vaccination, I will do it.	Facilitator	Women like you help their family stay healthy. To make this easier for you, here are the steps and resources of HPV vaccination for your child. Click here to read more. <List steps/resources of HPV vaccination>

4. SOFTWARE DESIGN

The HPV application accomplishes program objectives through an interactive conversation simulation. The user is presented with a conversational avatar (a nurse, in this case) who converses with the user regarding the virus, and steps s/he can take to reduce her/his child's risk of contracting HPV. A turn-based system is used, in which the avatar speaks, and the user is presented with response options. After the user responds, the avatar calculates a response and presents it to the user via text and speech (using the Speech API version 5.1) [35].

4.1 Application Objectives and Constraints

The HPV application has the following main objectives:

- Enhance knowledge regarding HPV and vaccines
- Prepare Latino parents of children at-risk for HPV to take steps to minimize the risk for their children
- Increase knowledge retention and maximize the learning margin
- Provide an interface to monitor the effectiveness of the application, and the learning margin of the participants

Additionally, the following constraint is considered primary:

- The target audience is a middle-aged, lower-income community. As such, technological proficiency is assumed to be low.

4.2 Conversation Tree

The response calculation considers the child's gender and the user's knowledge of the subject. If the user makes invalid assumptions or statements, a "remediation response" will be triggered to correct the misassumption, misconception, or invalid knowledge. An example of a conversation tree is shown in Figure 2. Depending on the user's child's statistics, a different conversation branch will be entered. This allows the information to be specific to the user and thus increase relevance. In turn, this is intended to increase the learning margin, by ensuring users are not burdened with irrelevant information.

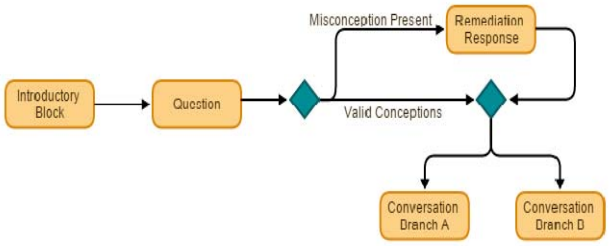

Figure 2. Conversation tree flowchart

4.3 Data Process and Technologies

When the user first uses the HPV application on the touchscreen tablet, s/he will complete a brief survey (T0). Each question in the T0 survey is mapped to a learning objective and is recorded. Throughout the application flow, the user selects responses, each corresponding to one or more learning objectives. At the end, the user takes another survey. Each portion of the interaction is recorded. Based on the data collected at different time points, the user's learning margin can be determined, thus measuring which topics are more prone to misconceptions than others and how beneficial the application is.

This application was developed using a user-driven approach. A prototype was created, shown to users, and then revised based on user feedback. This process was repeated, focusing on improvements to usability and learning outcomes. Table 2 describes the technologies used to build the application.

Table 2. Technologies used for development

Technology	**Purpose**
ASP.NET	Application content, data management, web front end
C#	Server client interaction, conversation tree and third party API integration
JavaScript/CSS	Client-side GUI, mobile device support
Speech API version 5.1	Text to speech conversion

4.4 Ethical Considerations

There are no physical risks associated with participation. Participants are informed that they can skip any questions they wish not to answer. To ensure confidentiality of participants, no personal identifiers (e.g., name, SSN) are collected. Participants create a unique user name when enrolled, so we can link the data collected at different time points. Data collected via computers were saved and managed using a secure, web-based application "REDCap" hosted at a HIPPA-compliant secure server via a university-wide research storage system. REDCap is designed to support data collection (Harris09; http://www.project-redcap.org/), and provides: (1) an intuitive interface for validated data entry; (2) audit trails for tracking data manipulation and export procedures; (3) automated export procedures for seamless data downloads to common statistical packages; and (4) procedures for importing data from external sources. All online

connectivity is via Secure Socket Layer (SSL) with maximum available (128 bit) encryption of data traffic to ensure HIPAA compliance. Data access is restricted to the staff who are on the Authorized Personnel list. Access is password protected and written standard operating procedures are used to protect the data from error, negligence, misconduct, conflict of interest, malicious acts, and catastrophe. We publish only aggregate data to protect the anonymity of the participants.

5. IMPLEMENTATION

Given clinicians' limited availability to provide health education, our computer-tailored program can be a feasible and cost-effective tool in a busy clinic environment to increase patients' health knowledge and to promote their behavioral changes.

We collaborate with County Department of Public Health to implement this program in a vaccine clinic that serves a primarily non- or under-insured population. We plan to collect 36 Latino parents to examine feasibility, acceptability, and preliminary efficacy (effect size). We will also interview four healthcare providers in the vaccine clinic to seek their opinions about integrating this tool into their daily clinic routine.

On a touchscreen tablet, eligible Latino parents first choose the language they prefer to use. They create a unique user ID based on our guideline. Once they enter the user ID, they choose the gender of the target child aged 11-17 who has not received HPV vaccination. After the welcome statement, they are led to messages tailored to their HPV-related knowledge, the risk they perceive of their child becoming infected with HPV, facilitators and barriers associated with their children's HPV vaccination, and cultural beliefs that influence their decision to vaccinate their adolescent children.

For the HPV knowledge items, participants receive slightly different feedback messages after they select an answer. If their answer is correct, the feedback message will start with "Congratulations…" If they answer incorrectly, the feedback message will be "Actually …" The purpose of showing the correct knowledge statement regardless of the answer is to reinforce the parent's understanding. For items about perceived risk, facilitators, barriers, and cultural beliefs, participants receive feedback message depending on condition that is applicable to them. For instance, for participants who select "Because my child's doctor or nurse does not suggest it" as a barrier to vaccinate their adolescent children against HPV, a feedback message will pop up to address this barrier: "Perhaps your doctor or nurse has not had the opportunity to tell you about getting your child vaccinated to prevent HPV infection. It's okay to ask your doctor or nurse about HPV vaccination for your child even if the doctor or nurse has not yet discussed it." Participants who do not select it as a barrier will not receive a feedback message and will be led to next barrier option.

An updated resource sheet containing local and state information about vaccine clinics and health insurance coverage will appear up when participants indicate a need (e.g., they do not know where to receive HPV vaccines and/or do not know if they are eligible for free or discount HPV vaccines). After participants complete the HPV education, which takes about 15-20 minutes, we thank them for their time and effort. Figure 3 demonstrates some of the features described above.

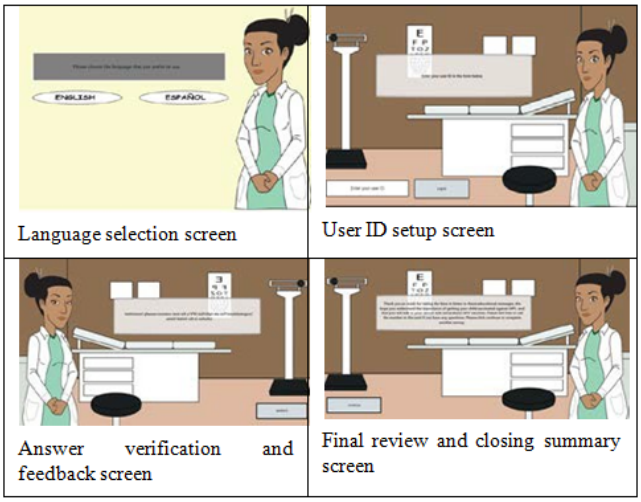

Figure 3. User Interaction Screens

In this computer-tailored education program, participants have the option of receiving the tailored messages verbally, narrated by a female voice (in both English and Spanish) instead of reading the messages. Messages addressing knowledge include 14 messages about HPV risk in the adolescent population, its link with cervical cancer and other diseases, how to prevent HPV, HPV vaccine type, dose and safety issues, and local resources for HPV testing and treatment. Nine messages were developed to address Latino parents' perceived risk regarding their child's acquisition of HPV infection based on child's age, sex, race/ethnicity, sexual behavior and orientation, family history of cancer, signs/symptoms, general health or other reasons. Ten messages were developed to address the facilitators for HPV vaccination, such as the health care provider's suggestions, encouragement from religious leaders/pastors, and beliefs that the HPV vaccination will save a child's life. We developed 21 messages to assess barriers (e.g., lack of health insurance, worry about the safety of the vaccines), and so the educational messages can be tailored based on barriers identified by each participant. Five messages about cultural beliefs relevant to HPV vaccination (e.g., faith in God can protect my child from the disease) are also included. Table 3 shows an example of the algorithm used in this application.

Table 3. HPV message algorithm

Label & Code	Number	Algorithm	Message Text
Child is girl (GEN=1)	0		
Child is boy (GEN=2)	0		
Only girls will get HPV infection (PR1; perceived risk)	M1	If GEN>=1 & PR1=1; then M1	Both girls and boys can get HPV infection.

6. PRELIMINARY FINDINGS

We have enrolled 20 Latino parents (mean age = 39.5; *SD* = 4.6). Sixteen of them (80%) chose the Spanish version program. A total of 15 participants have completed the education program and surveys. Majority of the participants were also to complete the education program and surveys in the clinic, suggesting the feasibility of implementing it in the clinic environment. Participants also showed high acceptability of the computer-tailored education program, evident by the acceptability score (range 11-44; mean score = 37.4). Regarding the length of the time required to complete the education program and surveys, 66.7% participants reported that "it is adequate," 6.7% said that "it is short," and 26.7% reported that "it is somewhat long." It was also encouraging to know that they have found the HPV application installed in the touchscreen tablet easy to use.

Our preliminary data suggested that Latino parents' intention to vaccinate their adolescent children have been increased after receiving this education program. In fact, three participants consented their children for the HPV vaccines right after completing our program, another three made appointments, and one expressed the interest but would wait until the child turned 13 years old.

This computer-tailored education program is innovative in several ways. First, it addresses a significant public health issue, HPV infection and associated cancers in both Latino adolescent boys and girls while most of the research in this area focuses only on girls. Second, the content is tailored to individual characteristics (e.g., gender of the targeted child) associated with the parents' decision about their child's HPV vaccination uptake. Thus, the tailored content is more relevant to the parents, and ultimately is more effective. Third, this education program is delivered by touchscreen tablets, which are user-friendly for individuals with limited experiences with technology. Fourth, individuals with lower health literacy are more likely to misunderstand and feel frustrated with health promotion education compared with individuals with adequate health literacy. We attempted to address this challenge by ensuring the bilingual intervention materials are at the 8th-grade reading level. The voiceover feature of the education also increased accessibility for low health literacy and low vision users.

7. CONCLUSION AND FUTURE WORK

We describe an innovative, computer-tailored, health education application aimed at increasing Latino parents' knowledge and intention to vaccinate their adolescent children against HPV. The preliminary findings based on this real-world testing are promising. Collaborating with a county vaccine clinic that serves primarily low-income ethnic minority population, we continue collecting data to examine its feasibility, acceptability and short-term efficacy in our target population. If it is shown to be feasible, acceptable and effective in clinical settings, implementing a computer-tailored education program to promote HPV vaccination can be time- and cost-effective.

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