A Pilot Study Examining the Efficacy of Delivering Colorectal Cancer Screening Messages via Virtual Health Assistants

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Introduction: Patients are more likely to complete colorectal cancer screening when recommended by a race-concordant healthcare provider. Leveraging virtual healthcare assistants to deliver tailored screening interventions may promote adherence to colorectal cancer screening guidelines among diverse patient populations. The purpose of this pilot study is to determine the efficacy of the Agent Leveraging Empathy for eXams virtual healthcare assistant intervention to increase patient intentions to talk to their doctor about colorectal cancer screening. It also examines the influence of animation and race concordance on intentions to complete colorectal cancer screening.

Methods: White and Black adults (N=1,363) aged 50−73 years and not adherent to colorectal cancer screening guidelines were recruited from Qualtrics Panels in 2018 to participate in a 3-arm (animated virtual healthcare assistant, static virtual healthcare assistant, attention control) message design experiment. In 2020, a probit regression model was used to identify the intervention effects.

Results: Participants assigned to the animated virtual healthcare assistant ($p<0.01$) reported higher intentions to talk to their doctor about colorectal cancer screening than participants assigned to the other conditions. There was a significant effect of race concordance on colorectal cancer screening intentions but only in the static virtual healthcare assistant condition ($p=0.04$). Participant race, age, trust in healthcare providers, health literacy, and cancer information overload were also significant predictors of colorectal cancer screening intentions.

Conclusions: Animated virtual healthcare assistants were efficacious compared with the static virtual healthcare assistant and attention control conditions. The influence of race concordance between source and participant was inconsistent across conditions. This warrants additional investigation in future studies given the potential for virtual healthcare assistant−assisted interventions to promote colorectal cancer screening within guidelines.
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INTRODUCTION

Colorectal cancer (CRC) is the second leading cause of cancer death in both men and women in the U.S., with 52,980 deaths expected in 2021.[1] Regular screening significantly improves CRC detection and overall survival.[2] Therefore, the U.S. Preventive Services Task Force recommends CRC screening for all patients aged 50−75 years.[3,4] Unfortunately, racial and ethnic minorities have lower rates of CRC screening and bear a greater burden of morbidity and mortality than other demographic groups.[5] Patients are more likely to be adherent to screening recommendations when delivered by a race-concordant provider.[6−12]

The increase in telehealth utilization owing to the coronavirus disease 2019 (COVID-19) pandemic presents an opportunity to leverage technology to improve screening adherence among under-represented patient populations. *Telehealth* refers to real-time audio-visual visits that deliver health-related services.[13] This definition includes interactions using tailored virtual healthcare assistants (VHAs).[14,15] Telehealth interventions may benefit from using VHAs because they account for patient preferences and resource availability. VHAs can be easily tailored to patient preferences, such as being paired with a race-concordant healthcare provider. VHAs can also overcome screening barriers by eliminating the requirement for patients to physically access a healthcare facility.[16−18]

This study pilot tested a telehealth intervention entitled Meet Agent Leveraging Empathy for eXams (ALEX). ALEX is an interactive, web-based VHA that educates patients about CRC risk and facilitates screening. The ALEX interface and content were designed in consultation with an interdisciplinary team of communication scientists, cancer scientists, physicians, computer scientists, and community members.[19] The pilot test examined the following research questions:

1. Does an animated VHA intervention increase CRC screening intentions compared with a static VHA intervention or attention control?
2. Do patients who receive a race-concordant VHA report higher CRC screening intentions?

METHODS

The study was conducted to investigate the effect of the Meet ALEX intervention on intentions to complete CRC screening utilizing a randomized trial with 3 arms (animated VHA, static VHA, attention control) in 2018. The animated VHA provided information verbally (with closed captioning), asked closed-ended questions, and used nonverbal behaviors. The static conditions provided the same content in text format accompanied by still photos of the VHA (Figure 1). VHA race and visual framing were nested within the 2 VHA conditions.[20] VHA race was operationalized as being concordant or discordant to participant's self-reported race. The attention control condition consisted of information about nutrition and cancer prevention presented in text format.

Participants (N=1,363) were members of a nationally representative panel maintained by Qualtrics. The inclusion criteria were as follows: age 50−73 years, U.S. resident, ability to read and write English, self-identification as Black (includes African American) or White, and self-report of CRC screening status as nonadherent to guidelines. Interested participants were directed to an online informed consent document approved by the University of Florida IRB. After consenting, participants completed screening questions that confirmed eligibility and were randomly assigned to a study arm. The mean age was 59.62 (SD=6.19) years, the majority (78.9%) were White, and approximately half were female (Table 1).

The primary outcome of the study was the intentions of the patients to talk to their doctor about CRC screening (i.e., *The virtual appointment made me want to discuss colon cancer screening options with my doctor*). Intentions were measured using a 5-point Likert scale. Analyses were conducted using R, version 4.0.1. Probit regression models were implemented to analyze the data in 2020 using the polr function in the MASS[21] package. The model contained the main effects of the attention control condition, animated VHA intervention, and static VHA intervention. Racial concordance was included as a nested effect within the animated and static VHA interventions. Sociodemographic variables were included as main effects to improve precision. For pairwise testing involving the control, animated VHA intervention, and static VHA intervention, *p*-values were corrected for multiple comparisons testing using the multivariate *t*-distribution method. When applicable, all *p*-values resulted from the use of 2-sided tests.

RESULTS

Research Question 1 asked whether exposure to an animated VHA intervention would result in higher intentions to talk to a doctor about CRC screening. Participants reported higher intentions to screen for CRC when the information was delivered via the animated VHA intervention compared with when it was delivered via the static VHA intervention ($p<0.05$) and the attention control condition ($p<0.01$). Reported effect sizes are increases in the predicted probability of observing a 5 for intentions to talk to a doctor followed by a 95% CI (Tables 2 and 3). The effect of the animated VHA intervention compared with that of the static VHA intervention was 8.36% (95% CI=7.44, 9.06). The effect of the animated VHA intervention compared with that of the attention control condition was 11.62% (95% CI=10.53, 12.36). There was no significant difference between the static VHA intervention and the control (Table 2). Table 3 provides a summary of the model output.

Figure 1. Screenshots of VHAs.
VHA, virtual health assistants.

Research Question 2 asked whether exposure to an intervention delivered by a race-concordant VHA would result in higher CRC screening intentions than that delivered by a race-discordant VHA. This hypothesis was

Table 1. Sociodemographic Characteristics of Patients (N=1,363)

Demographic information	*n* (%)
Age, years, mean (SD)	59.62 (6.19)
Sex	
Female	680 (49.9)
Male	683 (50.1)
Race	
Black	287 (21.1)
White	1,076 (78.9)
Ethnicity	
Hispanic or Latino	39 (2.9)
Not Hispanic or Latino	1,324 (97.1)

partially supported. There was a significant interaction effect between race concordance and condition such that participants who received a race-concordant source in the static VHA condition reported significantly higher CRC screening intentions than participants who received a race-discordant source ($p<0.05$). However, there was no significant difference in the main outcome between participants who received a race-concordant and those who received a race-discordant animated VHA.

Several sociodemographic and psychosocial variables emerged as significantly related to the primary outcome. A negative relationship was observed for age ($p=0.02$), such that younger participants reported higher intentions to talk to a doctor about CRC screening. Black participants reported higher CRC screening intentions ($p=0.01$), as did patients who had greater trust in their healthcare provider ($p<0.001$) and greater electronic health literacy ($p<0.01$). Cancer information overload

Table 2. Intervention Effects Controlling for Sociodemographic and Psychosocial Characteristics

Variables	B (SE)	*p*-value
Intervention conditions		
Animated VHA (ref) versus control	**0.32 (0.1)**	**0.003**
Static VHA (ref) versus control	0.08 (0.11)	0.74
Animated VHA (ref) versus static VHA	**0.24 (0.10)**	**0.041**
Interaction		
Static VHA X race concordance	**0.22 (0.11)**	**0.043**
Animated VHA X race concordance	−0.04 (0.08)	0.633
Sociodemographic characteristics		
Age	**−0.01 (0.00)**	**0.02**
Race (Black)	**0.20 (0.08)**	**0.008**
Sex (female)	0.04 (0.06)	0.52
Health insurance (yes)	0.09 (0.08)	0.28
Education	−0.01 (0.02)	0.64
Psychosocial characteristics		
Cancer information overload	**−0.13 (0.03)**	**<0.001**
Trust in healthcare provider	**0.35 (0.03)**	**<0.001**
eHealth literacy	**0.10 (0.03)**	**0.002**
Intercepts		
1|2	**−0.96 (0.37)**	—
2|3	**−0.46 (0.37)**	—
3|4	0.35 (0.37)	—
4|5	**1.15 (0.37)**	—

Note: Boldface indicates statistical significance (*p*<0.05).
The technical supplement contains a more detailed summary of the procedure used to convert the regression coefficients to percentages.
B, beta, the estimated regression coefficient; VHA, virtual health assistant.

Table 3. Change in Predicted Probability for Main Effects

Intervention conditions	Δ Probability of 5 (95% CI)
Animated VHA (ref) versus control	11.62% (10.53, 12.36)
Static VHA (ref) versus control	2.76% (2.42, 3.01)
Animated VHA (ref) versus static VHA	8.36% (7.44, 9.05)

VHA, virtual health assistant.

(*p*<0.001) was negatively related to CRC screening intentions. There were no significant associations with cancer screening intentions detected for sex, health insurance status, or education.

DISCUSSION

The goal of this pilot study was to determine the feasibility of a tailored, web-based VHA intervention to promote CRC screening. The results show that tailoring a CRC screening intervention using an animated VHA is feasible and is associated with higher intentions to complete CRC screening than using both the static and control conditions. This finding is promising given that intentions are a strong predictor of screening behavior.[22] The study also provides preliminary data on the benefits and limitations of race concordance in virtual contexts. Racial concordance was significant only in the static VHA condition. This could indicate that presenting visual cues in isolation may increase the salience of social group characteristics (e.g., race), whereas the addition of verbal and nonverbal cues may increase the salience of interpersonal characteristics (e.g., friendliness).[23,24]

Limitations

A limitation of the study is that participants were enrolled from a national panel. Panel participants may be more comfortable with online studies and have greater access to online health information than the general patient population. In addition, investigators did not follow-up with participants to verify whether they discussed CRC screening with a healthcare provider.

CONCLUSIONS

Because of COVID-19, telehealth visits are an essential component of preventive medicine. This pilot study provides preliminary evidence of the feasibility and potential efficacy of delivering patient education using VHAs. Additional research is needed on the benefits and limitations of race matching in telehealth contexts as well as in

implementing VHA-assisted interventions to promote CRC screening in clinical settings.

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SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2021.01.014.

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