Can virtual human clinicians help close the gap in colorectal cancer screening for rural adults in the United States? The influence of rural identity on perceptions of virtual human clinicians

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ABSTRACT

Rural adults experience disparities in colorectal cancer screening, a trend even more distinct among rural Black adults. Healthcare disruptions caused by COVID-19 exacerbated inequities, heightening attention on virtual communication strategies to increase screening. Yet little is known about how rural adults perceive virtual human clinicians (VHCs). Given that identifying as rural influences perceived source credibility often through appearance judgments, the goal of this pilot was to explore how to develop VHCs that individuals highly identified with rurality find attractive. Between November 2018 and April 2019, we tested a culturally tailored, VHC-led telehealth intervention delivering evidence-based colorectal cancer prevention education with White and Black adults (N = 2079) in the United States recruited through an online panel who were non-adherent to screening guidelines and between 50 and 73 years of age. Participants were randomized on three factors (VHC race-matching, VHC gender-matching, Intervention type). Ordinal logistic regression models examined VHC appearance ratings. Participants with a high rural identity (AOR = 1.12, CI = [1.02, 1.23], p =.02) rated the VHCs more attractive. High rural *belonging* influenced VHC attractiveness for Black participants (AOR = 1.22, CI = [1.03, 1.44], p =.02). Also, Black participants interacting with a Black VHC and reporting high rural *self-concept* rated the VHC as more attractive (AOR = 2.22, CI = [1.27, 3.91], p =.01). Findings suggest adults for whom rural identity is important have more positive impressions of VHC attractiveness. For patients with strong rural identities, enhancing VHC appearance is critical to tailoring colorectal cancer prevention interventions.

1. Introduction

Colorectal cancer is the second leading cause of cancer death in the United States. In 2022, it is estimated that 151,030 people will be diagnosed with colorectal cancer, and 52,580 people will die from the disease ((American Cancer Society, 2022). Colorectal cancer mortality can be reduced by timely screening (Loomans-Kropp and Umar, 2019); unfortunately, due in part to structural challenges (e.g., access, cost), rural adults are less likely to get screened and experience disproportionate disease burden (Anderson et al., 2013: Henley et al., 2017; Moreno et al., 2020; Zahnd et al., 2021). Colorectal cancer disparities are even more distinct among rural Black adults (Rogers et al., 2020; Zahnd et al., 2021). As singular communication strategies are ineffective in meeting the needs of diverse subgroups, there is an urgent need to develop screening interventions that deliver culturally tailored messaging to rural adults to close gaps in the prevention and early detection of colorectal cancer.

Advancements in telehealth delivery through virtual human

technology offer a cutting-edge opportunity to provide evidence-based colorectal cancer prevention messaging. Using virtual human clinicians (VHCs), computer-based conversational agents that interact with patients by presenting human attributes (e.g., facial expressions, hand gestures, speech), screening education can be provided in a consistent manner that reduces barriers (Bickmore et al., 2009). Prior research on virtual agents has found them effective in addressing various health behaviors, including alcohol consumption, personal fitness, and nutrition (Lisetti et al., 2013; Lucas et al., 2018; Olafsson et al., 2020) . VHCs can serve as social models and offer customizable interactions that match patient characteristics (e.g., race, gender, language) (Baylor and Kim, 2004; Krieger et al., 2021; Provoost et al., 2017; Zalake et al., 2021).

VHC-led interventions can be tailored to patient preferences, impacting message processing and relevance (Hawkins et al. 2008). Rural patients have unique needs, given the lack of medical workforce diversity and clinician shortages. VHCs in telehealth offer a low-cost alternative to face-to-face care that reduces travel constraints while improving access and choice for rural patients, contributing to increased satisfaction (Bernardo et al., 2018; Kamran et al., 2022; Orlando et al., 2019). Prior work has shown tailored virtual agents to be effective in educating rural populations about cancer (Mendu et al., 2018). Further, patients with low health literacy, which is increasingly likely among rural adults, often find VHC-led interventions acceptable and easy to use (Bickmore et al., 2009). In sum, current literature on VHCs suggests they are an appropriate communication strategy for rural patients to increase the utilization of colorectal cancer screening.

Perceived clinician credibility can influence patient response to recommendations (Polinski et al., 2014) . One way to enhance credibility in face-to-face encounters is racial concordance between patient and clinician (Street et al., 2008; Thornton et al., 2011) . In the telehealth context, VHC credibility has a positive influence on colorectal cancer screening intention (Cooks et al., 2022). Matching patients with a race-concordant VHC can also positively influence screening intentions due to increased credibility (Cooks et al., 2022; Griffin et al., 2019; Hung et al., 2020; Krieger et al., 2021; Shen et al., 2018; ter Stal et al., 2020). Intentions to screen are often positively associated with screening completion (Brumbach et al., 2017; Birmingham et al., 2015). However, knowledge of how rural adults perceive VHC credibility is lacking, limiting the ability to tailor effective interventions.

One key dimension of credibility is attractiveness; message sources rated as more attractive are often more persuasive and generate increased behavioral motivation (Baylor et al., 2009; Cialdini, 2001; Cialdini and Goldstein, 2004; Chaiken, 1979; Ohanian, 1990; Wilson-Howard et al., 2021). The flexibility of VHCs allows for systematic enhancements to appearance. Recent findings in developing culturally appropriate VHCs for rural Black adults suggest credibility is influenced by technical quality and appearance (Vilaro et al., 2021a; Wilson-Howard et al., 2021). Simply put, VHC appearance is an indicator of credibility, particularly among rural adults, which influences colorectal cancer screening intentions. Thus, the appearance of a message source is an important factor for enhancing the credibility of interventions to encourage screening in rural populations.

There is, however, a lack of consistency in how rurality is measured; it is frequently defined geographically, yet the strength with which an individual identifies themselves as being rural can significantly influence behavior (Ratcliffe et al., 2016). Like other forms of group-based membership, such as racial and ethnic identity, rural identity functions to reduce uncertainty, specifically within a social "place" as members accept cultural norms and behavior (Tajfel, 1979; Twigger-Ross et al., 2003). This "sense of place" suggests a relationship between individuals and their environment where bonds with places, including their value and meaning, are continuously reconstructed (Lengen and Kistemann, 2012). The four-item rural identity scale first used by Krok-Schoen et al. (2015) taps four dimensions: (1) place identity (e.g., bond generated with places through observation of values,

thoughts, and ideas [Qazimi, 2014]), (2) self-concept (e.g., personal identification as "rural"), (3) similarity (e.g., alignment with rural culture and values), and (4) sense of belonging (e.g., community connection). However, the scale performance in capturing rurality has not been explored within virtual cancer screening interventions.

This pilot study tested a VHC-led intervention entitled Meet "ALEX" (Agent Leveraging Empathy for eXams), providing evidence-based colorectal cancer prevention education(Griffin et al., 2019; Zalake et al., 2021) . A challenge to communicating the importance of colorectal cancer screening to a rural audience is the perception that a message source is a cultural "outsider," which can be reduced through appearance adjustments (e.g., clothing, accessories, etc.) to increase message acceptance (Palmer-Wackerly et al., 2014; Hardy et al., 2019). The importance of VHC appearance for credibility and acceptability among rural adults was also a consistent theme during user-centered ALEX development. One tester commented, "Like I say, being as that he was a brother-doctor look, it was more acceptable to listen to it opposed to another type," while another mentioned, "I don't want to go to nobody looking all weird and start asking me questions" (Vilaro et al., 2021b; Wilson-Howard et al., 2021). Given the importance of VHC appearance, the purpose of this pilot was to explore how to develop VHCs that rural adults would find attractive. Considering that tailoring health interventions involves attending to the influence of cultural norms and beliefs (Kreuter et al., 2003) and that sociocultural aspects of rurality (e.g., cultural values, perceptions) can influence user experiences with technology (Hardy et al., 2019), the role of rural identity was examined. Several research questions were investigated:

RQ1a: Is rural identity associated with evaluations of VHC appearance?

RQ1b: How do rural identity and race interact to influence evaluations of VHC appearance?

RQ2: How do rural identity and VHC race-matching interact to influence evaluations of VHC appearance among Black adults?

RQ3: How do the different dimensions of rural identity relate directly and intersect with race and VHC race-matching to influence evaluations of VHC appearance?

2. Materials and methods

Meet ALEX was developed as part of a National Cancer Institute-funded project (1R01CA207689-01) and approved for human-subjects research by a local institutional review board. Development is described below and more thoroughly elsewhere (Griffin et al., 2019; Zalake et al., 2021).

2.1. Design

After consenting, participants were randomized to one of eight treatments based on VHC race-matching (matched, not-matched), VHC gender-matching (matched, not-matched), and intervention type (interactive, static). This study focuses on rural identity effects related to VHC race-matching. Statistical models did not consider VHC gender-matching and intervention type and have been reported elsewhere (Cooks et al., 2022; Krieger et al., 2021).[1]

2.2. Intervention

Using computer-generated characters to engage patients in a one-one conversation about colorectal cancer prevention, ALEX is a VHC located in a digital exam room that can be matched to patient race and gender (see Fig. 1). ALEX was developed to address colorectal cancer screening

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[1] Participants assigned to the interactive VHC had higher intentions to screen and greater perceptions of VHC credibility. No main effects for VHC gender were found.

Fig. 1. Images of the Meet ALEX virtual clinicians.

disparities through a cross-disciplinary partnership of communication, cancer, and computer scientists, clinicians, and community members. Focus groups and think-aloud interviews with over 120 diverse community members within the research team's largely rural catchment area informed the iterative user-centered design process, including enhancements to VHC appearance. Phase 1 collected information on user preferences and needs before prototype development. In Phase 2, users tested the prototype and commented on character details that informed refinement (e.g., added white coat, changed lighting, removed gray hair). Phase 3 included additional feedback on VHC appearance (e.g., added smile, focused eye gaze, changed hairstyle), leading to final modification (see Vilaro et al., 2020; Wilson-Howard et al., 2021). Efforts were made to reduce the health literacy for engagement (i.e., visuals of stool sample collection rather than words). The interactive ALEX provides colorectal cancer screening information verbally with closed captioning, asks closed-ended questions, and uses nonverbal behaviors; users receive personalized prevention messaging based on responses (see supplement for link). The static ALEX provides identical content in text and still photos. ALEX is a patient-centered intervention that addresses various screening modalities (e.g., colonoscopy, Cologuard, FIT) (For more information on the ALEX intervention, see Cooks et al., 2022; Krieger et al., 2021).

2.3. Sample selection and data collection

Between November 2018 and April 2019, a total of 2,267 participants recruited from a nationally representative Qualtrics panel of individuals who agreed to research participation were randomized into this online experiment; 201 did not complete the post-intervention questionnaire and were excluded from analysis, leaving a final sample of 2,066 participants. Qualtrics was selected for recruitment to pilot this intervention before moving into a clinical population. Panel members were emailed an invitation link and completed eligibility questions. A total of 24,732 individuals began the survey, and more than 22,000 were screened out (due primarily to being within screening guidelines). Eligibility criteria included: (a) United States residents aged 50–73, (b) able to read in English, (c) self-identifying race as Black or White Non-Hispanic,[2] (d) non-adherent with colorectal cancer screening guidelines, and (e) providing informed consent. Although colorectal cancer screening is currently recommended for individuals aged 45 to 75 years, at the time of this study, screening guidelines had not been revised to include patients 45–49 years of age.[3] Further, we set the upper limit to 73 to ensure eligibility for the study duration.

2.4. Measures

The primary outcome measured was VHC appearance quality measured as attractiveness (McCroskey and Teven, 1999). Using a 5-point semantic differential (labeled "unattractive-attractive"), the item read, "ALEX was your virtual healthcare assistant who provided you the health information during your virtual appointment. ALEX is….". (M =

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[2] The current iteration of Meet ALEX can be customized on race only for Black and White patients. Future plans include additional research to test ALEX with an expanded patient population.

[3] The recommended age for colorectal cancer screening was adjusted in May 2021 to include patients 45–49 years of age.

4.6, SD = 0.7). Rural identity was assessed using a four-item measure (α = 0.92, M = 2.7, SD = 1.3), capturing different facets of deriving a sense of self from social group memberships (Krok-Schoen et al., 2015). Specifically, on a 5-point Likert scale, the items measure rural *place identity* ("How much is being from a rural community a part of who you are?" M = 2.5, SD = 1.4), *self-concept* ("How much do you identify with people who live in rural communities?" M = 2.9, SD = 1.3), *belonging* ("How much do you see yourself as belonging to a rural community?" M = 2.6, SD = 1.5), and *similarity* ("To what extent do you feel your general attitudes and opinions are similar to people who live in rural communities?" M = 3.0, SD = 1.3).

2.5. Analysis plan

Statistical analyses were conducted using R 4.0.1 (R Core Team, 2018). Ordinal logistic regression models were implemented with the *clm* function in the ordinal package. An ordinal logistic regression model with a logit link function is called a proportional-odds model. We implemented five ordinal regression models corresponding to the median of the rural identity measure along with each of its four items. To evaluate the proportional odds assumption, we conducted a Brant Test using the "brant" package in R; this assumption was supported ($p = 0.89$). The estimated regression coefficients of each model represent log-odds ratios, which were transformed into odds ratios through exponentiation (see Stoltzfus, 2011 for a review). Models used perceived VHC attractiveness as a dependent variable and contained up to three-way interactions between participant race, rural identity, and VHC race-matching[4] as features. Rural identity was coded as a continuous variable. The mean absolute error was formulated to assess model fit, with the value between the predicted and observed perceived VHC attractiveness being 0.88.

Analyses were conducted to determine the influence of rural identity on the relationship between VHC race-matching and VHC attractiveness. We used two 2-sided Z-tests to identify the main effects of participant race, rural identity, and VHC race-matching. We also used Z-tests to determine whether rural identity influenced the relationship between VHC race-matching and VHC attractiveness based on participant race. To do this, we conducted four hypothesis tests that required examining linear combinations of regression coefficients (see technical supplement for more information). We tested the effect of VHC race-matching against race-mismatching amongst Black participants with high rural identity. A similar test was conducted with Black adults with low rural identity and among White participants based on rural identity identification. High identification was defined as an item response of '5', and low identification as a response of '1'. All hypothesis tests were conducted at a 0.05 significance level. We provide adjusted odds ratios (AOR) and 95 % confidence intervals for each tested effect.

3. Results

3.1. Sample characteristics

Table 1 describes sample demographics. Participants were primarily female (59.9 %), with an average age of 58.7 (SD = 6.2). Among this sample, 37.1 % (n = 840) identified as Black or African American. Further, over 60 % had at least some post-secondary education, and income level displayed a fairly even distribution. Table 2 presents responses at each scale level for rural identity items overall and by participant race/VHC race-matching interaction.

Table 1
Sample characteristics (N = 2267).

Characteristic	
Age, mean (SD)	58.7 (6.2)
Gender, No. (%)	
Man	908 (40.1 %)
Woman	1359 (59.9 %)
Race, No. (%)	
Black	840 (37.1 %)
White	1427 (62.9 %)
Educational Attainment	
College graduate	475 (22.8 %)
Technical, trade or vocational school AFTER high school	559 (26.9 %)
High school incomplete (completed grades 1–8)	41 (2.0 %)
Post-graduate training/professional school after college (MA, Ph. D., JD, or MD)	195 (9.4 %)
Some college	809 (38.9 %)
Income	
Less than $10,000	142 (6.8 %)
$10 – $20,000	298 (14.3 %)
$20 – $30,000	338 (16.3 %)
$30 – $40,000	246 (11.8 %)
$40 – $50,000	198 (9.5 %)
$50 – $75,000	336 (16.2 %)
$75 – $100,000	204 (9.8 %)
$100,000 or more	158 (7.6 %)

3.2. RQ1: Are rural identity and race associated with evaluation of VHC appearance?

RQ1 explored the relationship between rural identity and VHC appearance and whether participant race influenced this association (Table 3). Individuals with high rural identity rated the ALEX VHC as significantly more attractive ($AOR = 1.12$, CI = [1.02, 1.23], $p = .02$) compared to those with low rural identity; race did not have a significant influence on this effect ($AOR = 1.19$, CI = [0.99, 1.44], $p = .07$).

3.3. RQ2: Are rural identity and VHC race-matching associated with evaluations of VHC appearance among Black adults?

RQ2 considered whether the association between VHC race-matching and VHC attractiveness is affected by differences in rural identity among Black adults (Table 3). This interaction effect was statistically significant; for Black adults with high rural identity, being matched with a Black VHC was associated with higher attractiveness ratings ($AOR = 1.91$, [1.02, 3.56], $p = 0.04$). In other words, the odds of a 1 unit increase in perceived VHC attractiveness is 1.91 times larger than a 1 unit decrease in attractiveness for race-matched Black participants with high rural identity, compared to race-mismatched Black participants who also identify strongly with rurality (Fig. 2).

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[4] Separate models were analyzed for the composite rural identity score along with each of the four individual items.

Table 2

Proportion of responses across items, overall and by race/virtual human clinician (VHC) race-matching.

Study variable	Overall % (n)	Participant Race/Race-Matching % (n)			
		Black/Matched	Black/Mis-matched	White/Matched	White/Mis-matched
Belonging					
1	33.5 (697)	39.6 (133)	42.4 (134)	33.6 (179)	28.0 (251)
2	14.9 (310)	13.7 (46)	13.0 (41)	15.2 (81)	15.9 (142)
3	21.3 (442)	21.4 (72)	19.3 (61)	19.4 (103)	23.0 (206)
4	13.9 (289)	11.3 (38)	13.6 (43)	15.8 (84)	13.9 (124)
5	16.4 (341)	14.0 (47)	11.7 (37)	16.0 (85)	19.2 (172)
Place identity					
1	36.9 (767)	46.1 (155)	44.3 (140)	37.8 (201)	30.3 (271)
2	14.5 (301)	11.6 (39)	16.1 (51)	13.9 (74)	15.3 (137)
3	20.5 (426)	18.5 (62)	16.1 (51)	19.2 (102)	23.6 (211)
4	14.7 (306)	10.4 (35)	13.3 (42)	17.5 (93)	15.2 (136)
5	13.4 (279)	13.4 (45)	10.1 (32)	11.7 (62)	15.6 (140)
Self-concept					
1	20.4 (425)	22.9 (77)	25.0 (79)	21.4 (114)	17.3 (155)
2	17.5 (364)	15.8 (53)	19.3 (61)	16.7 (89)	18.0 (161)
3	27.2 (566)	29.3 (98)	25.6 (81)	25.4 (135)	28.2 (252)
4	20.0 (415)	15.5 (52)	18.4 (58)	22.6 (120)	20.7 (185)
5	14.9 (309)	16.7 (56)	11.7 (37)	13.9 (74)	15.9 (142)
Similarity					
1	17.0 (353)	19.9 (67)	20.6 (65)	16.9 (90)	14.6 (131)
2	17.2 (358)	18.2 (61)	17.8 (56)	17.1 (91)	16.8 (150)
3	31.8 (660)	32.1 (108)	33.0 (104)	30.8 (164)	31.7 (284)
4	21.3 (443)	18.8 (63)	17.5 (55)	22.2 (118)	23.1 (207)
5	12.7 (264)	11.0 (37)	11.1 (35)	13.0 (69)	13.7 (123)
VHC attractiveness					
1	(1.9) 40	1.2 (4)	1.9 (6)	3.4 (18)	1.3 (12)
2	(2.9) 60	2.1 (7)	1.9 (6)	3.4 (18)	3.3 (29)
3	(43.0) 889	30.0 (100)	38.3 (120)	52.4 (278)	43.9 (391)
4	(25.0) 516	23.1 (77)	25.2 (79)	25.6 (136)	25.1 (224)
5	(27.2) 563	43.5 (145)	32.6 (102)	15.3 (81)	26.4 (235)

3.4. RQ3: How do the different dimensions of rural identity relate directly and intersect with race and VHC race-matching to influence evaluations of VHC appearance?

3.4.1. Main effects of identity and attractiveness

RQ3 assessed each item of the rural identity measure separately to explore whether these factors function differently (Table 3). Three of the four dimensions displayed a significant relationship with VHC attractiveness. Regardless of their race, participants with high perceived *similarity* with rural communities ($AOR = 1.14$, CI = [1.03, 1.26], $p = .01$) rated the VHC as more attractive. Also, a high rural *self-concept* ($AOR = 1.12$, CI = [1.01, 1.22], $p = .03$), and *place identity* ($AOR = 1.09$, CI = [1.00, 1.19], $p = .05$) with rural communities were positively associated with VHC attractiveness. Sense of *belonging* to a rural community had little effect ($AOR = 1.06$, CI = [0.98, 1.16], $p = .15$).

3.4.2. Identity and race interaction

However, the analysis revealed that rural *belonging* was important to VHC perceptions for Black participants, as those with a high sense of *belonging* rated the VHC more attractive than similar Whites ($AOR = 1.22$, CI = [0.95, 1.03, 1.44], $p = .02$).

3.4.3. Identity and race-matching interaction

Lastly, the influence of rural identity on the VHC race-matching effect among Black adults was significant for only one dimension of identity; matching Black participants with a Black VHC was a cue for increased attractiveness only when rural *self-concept* was high ($AOR = 2.22$, CI = [1.27, 3.91], $p = 0.01$).

4. Discussion

How a patient perceives the appearance of a health message source can influence credibility, and rural adults often rely on appearance cues to make judgments on trustworthiness. This study explored how differences in rural identity and related components influenced VHC appearance ratings. Participants with high rural identity rated the VHCs as more attractive, regardless of their race or VHC type. However, participant race had a meaningful effect when rural *belonging* was high, as Black adults with high *belonging* saw the VHCs as more attractive than Whites. Further, being matched with a Black VHC led to higher attractiveness ratings for Black adults with high rural identity. Yet, this relationship was more nuanced as only a high rural *self-concept* had a significant effect.

These findings support the importance of rural identity in user experience with VHC-delivered interventions and inform intervention tailoring. Also, the intersection of race and rural identity underscores the need to account for rural identity as part of efforts to address racial cancer health disparities. Appearance evaluations are critical in this digital context, given source attractiveness positively influences acceptance of cancer prevention messaging and colorectal cancer screening intentions (Baylor, 2009; Cooks et al., 2022; Liao et al., 2019; Patzer, 1983; Valinatajbahnamiri and Siahtiri, 2021). Therefore, it is imperative that digital colorectal cancer screening interventions targeting rural disparities allocate resources to develop culturally appropriate VHCs that optimize appearance.

Table 3

Effect sizes of rural identity, participant race, and VHC race-matching on VHC attractiveness.

Predictor Variable		VHC Attractiveness		
		AOR	95 % CI	P*
Main Effects	*Interactions*			
Overall Rural Identity		**1.12**	**[1.02, 1.23]**	**0.02**
	x Participant Race (White – ref)	1.19	[0.99, 1.44]	0.07
	x VHC Race-Matching (Not-matching – ref)	**1.91**	**[1.02, 3.56]**	**0.04**
Belonging		1.06	[0.98, 1.16]	0.15
	x Participant Race (White – ref)	**1.22**	**[1.03, 1.44]**	**0.02**
	x VHC Race-Matching (Not-matching – ref)	1.75	[0.95, 3.21]	0.07
Place identity		**1.09**	**[1.00, 1.19]**	**0.05**
	x Participant Race (White – ref)	1.14	[0.96, 1.35]	0.13
	x VHC Race-Matching (Not-matching – ref)	1.78	[0.96, 3.31]	0.07
Self-concept		**1.12**	**[1.01, 1.22]**	**0.03**
	x Participant Race (White – ref)	1.09	[0.91, 1.32]	0.33
	x VHC Race-Matching (Not-matching – ref)	**2.22**	**[1.27, 3.91]**	**0.01**
Similarity		**1.14**	**[1.03, 1.26]**	**0.01**
	x Participant Race (White – ref)	1.20	[0.98, 1.46]	0.07
	x VHC Race-Matching (Not-matching – ref)	1.57	[0.87, 2.83]	0.13

Abbreviation: VHC, virtual human clinician.

Note: The interactions with VHC race-matching are a within-race analysis among Black participants.

4.1. Rural identity and VHC appearance

Regardless of the VHC they interacted with, individuals with a higher rural identity had more positive impressions of appearance. Prior work suggests rural adults prefer VHCs seen as calm and with a smiling and inviting face (Vilaro et al., 2021a). The current study suggests adults with high rural identity may be even more attuned to VHC appearance, possibly due to sociocultural norms for rurality that value virtual agents being similar to community members as a credibility indicator (Mendu et al., 2018). This finding could also result from intergroup categorization and identity priming through intervention engagement. Humans have many identities (e.g., ethnicity, class, religion) that cannot all be psychologically active, and high identification increases access to these identities; therefore, individuals with higher rural identity may be more easily primed to engage with this piece of their self-concept (Gaertner and Dovidio, 2000). A strong, salient rural identity would then contribute to VHC evaluations compatible with group norms.

4.2. Race, rural identity, and VHC appearance

Black adults face structural challenges such as access and cost that contribute to racial disparities in colorectal cancer screening (Geiger, 2003; Muthukrishnan et al., 2019), and for rural Black adults, these challenges are even more pronounced (Caldwell et al., 2016; James
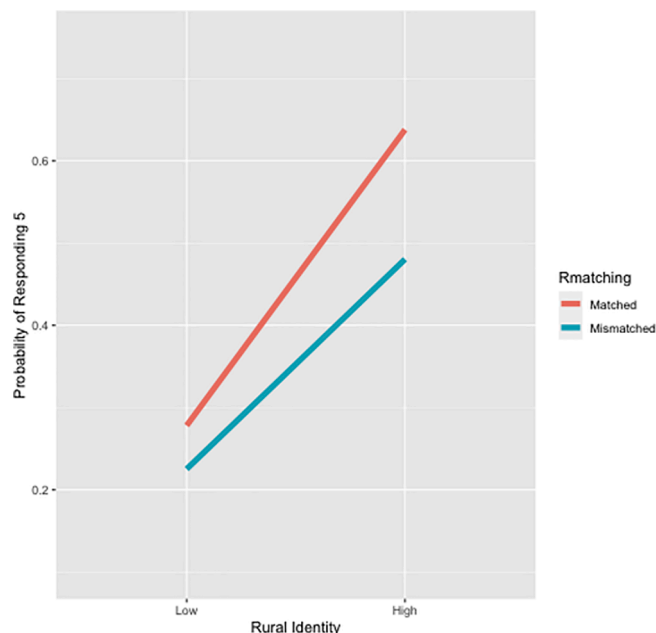

Fig. 2. Interaction effect of virtual human clinician (VHC) race-matching and rural identity on evaluation of VHC attractiveness.

et al., 2017; Zahnd et al., 2021) , . VHCs offer a low-cost option for prevention education; this capacity to minimize screening challenges highlights the importance of developing tailored experiences for diverse populations.

In this study, Black participants with a higher sense of rural *belonging* rated the VHCs as more attractive. A strong sense of *belonging* creates strong bonds of trust and obligation (Hogg, 2010). It can be reasoned that shared negative experiences with rural healthcare systems (e.g., structural racism, discrimination) foster a strong sense of rural *belonging* among Black adults (Fowler-Brown et al., 2006; Hammonds and Reverby, 2019). More specifically, rural Black adults may attend more closely to VHC features such as clothing and perceived professionalism (Vilaro et al., 2021a). This differential effect based on race may be explained by the fact that identifying as both Black and rural represents two stigmatized identities, creating a novel intervention response.

4.3. VHC race-matching and VHC appearance

Rural identity also influenced VHC attractiveness ratings for Black participants matched with a Black VHC. Because social groups seek a positive self-image, they often rate other members more favorably (Hornsey et al., 2008). Therefore, Black adults may rate Black VHCs as more attractive given perceived similarity, an effect enhanced by increased rurality (Joyce and Harwood, 2014). Item analysis revealed that VHC race-matching for Black participants was a significant cue for attractiveness only when rural *self-concept* was high, suggesting racial concordance maybe even more important for these individuals. Response to lack of diversity in the medical workforce may also explain this finding (Winkfield et al., 2021); Black adults who see rural identity as central to who they are may rate Black VHCs as more attractive because of their novelty and presentation of a non-traditional source of medical information.

4.4. Strengths and limitations

Findings of this pilot study are building blocks to more precisely tailored VHC-led cancer screening interventions for rural adults. Given the established relationship between source attractiveness and message persuasiveness, the positive association between rural identity and VHC

attractiveness implies screening interventions targeting rural adults should maximize the appearance of these conversational agents. Further, the fact that race concordance served as a strong cue for VHC attractiveness among Black adults with high rural identity suggests that race-matching is a vital intervention component for this group. Lastly, these findings provide a novel contribution to the study of VHC-led interventions by exploring the association between rural identity and perceived attractiveness across four factors of identity.

This study is not without limitations. A national panel was used for recruitment; these individuals may be more familiar with online platforms. However, online panels such as Qualtrics can recruit diverse samples for cancer research (Miller et al., 2020). It takes many years to fully disseminate a telehealth intervention, increasing the utility of piloting with early adopters. This pilot study aimed to explore patient experience with this intervention before moving into a clinical population. Also, given the use of a national panel, some participants may have increased access to technology. While over 70 % of rural communities have access to broadband service (Federal Communications Commission, 2020), there is a portion of this population that does not. As with all interventions, dissemination of Meet ALEX is not a one-size-fits-all approach.

Further, there are promising policies (e.g., the "ReConnect" program [usda.gov/broadband]) that will expand broadband in the United States, indicating the importance of identifying evidence-based interventions that are ready for broad deployment. Finally, a potential limitation is that rurality is a social construction and can be defined differently. Yet, the fact that these relationships with rural identity were found across a national sample suggests commonalities that inform intervention development.

5. Conclusion

This study is a next step in the line of research showing VHC appearance matters. With the COVID-19 pandemic disrupting cancer screening, there are significant opportunities to leverage VHCs to minimize challenges to screening uptake. VHC-led screening interventions to address rural disparities should invest adequate resources to maximize VHC appearance, particularly when targeting Black adults with an increased sense of *belonging* to a rural community. Further, VHC race-matching may be even more critical for Black adults who strongly identify with rurality, especially those with a greater rural *self-concept.* As the use of VHCs to deliver care grows, the examination of intergroup behavior in this context will only increase in importance. These findings resonate with the call to action for tailored strategies communicating the "why," "when," and "what" of colorectal cancer screening from preferred message sources. By focusing on the experiences of individuals highly identified with rurality, this study pushes the boundaries of our understanding of the role of group identity in VHC-led interventions.

Ethics. The study was approved by the University of Florida Institutional Review Board. Informed consent was obtained from all individual participants included in the study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Role of Funding Source

The research presented in this paper is that of the authors and does not reflect the official policy of the NIH.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2022.102034.

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