Reflections From A Clinical Trial: Examining Black Older Adults' Perceptions and Use of Digital Voice Assistants for Exercise

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Abstract

Digital voice assistants can help older adults engage in preventative health behaviors in a home setting. Over four years, we partnered with medical researchers who set up and conducted a six-month clinical trial of a voice assistant exercise program versus a paper exercise program. The trial focused on Black older adults in a lower-income area of a city who had health conditions that made it difficult for them to leave home. We conducted two qualitative studies (N=35 total), pre- and post-clinical trial: 1) to understand how older adults in this population perceive voice assistants (Alexa) and 2) to draw out motivating factors for exercise and how these vary between the two trial groups. Our findings show that for both the voice assistant and paper groups, social support was the main motivating factor to exercise. We also discuss design implications for voice assistants to support healthy aging.

CCS Concepts

• **Human-centered computing → Empirical studies in HCI**.

Keywords

older adults, preventative health, exercise, voice assistants, voice agents, voice interface, randomized controlled trial, clinical trial

ACM Reference Format:
Kelly B. Wagman, Arthur Borem, Lan Gao, and Marshini Chetty. 2026. Reflections From A Clinical Trial: Examining Black Older Adults' Perceptions and Use of Digital Voice Assistants for Exercise. In *The 28th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '26), October 25–28, 2026, Vila Nova de Gaia, Portugal.* ACM, New York, NY, USA, 20 pages. https://doi.org/10.1145/3797867.3829035

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ASSETS '26, Vila Nova de Gaia, Portugal
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ACM ISBN 979-8-4007-2521-0/26/10
https://doi.org/10.1145/3797867.3829035

1 Introduction

Minoritized older adults[1] often have worse health outcomes and face obstacles to receiving care [5, 107]. Yet, preventative health measures,[2] such as physical activity and mobility exercises, can improve their health outcomes—preventing frailty, improving sleep and blood pressure, and reducing the risk of falling, heart disease, cancer, dementia, depression and anxiety [22, 23, 48, 75]. These measures help minoritized older adults to retain mobility and independence as they age. However, many older adults have difficulty accessing in-person preventative health resources due to disability and chronic illnesses; one in five community-dwelling older adults (i.e., those who do not live in assisted care facilities) require some help to leave their homes [78].

These difficulties are further exacerbated in minoritized communities, leading to negative health outcomes [107]. In 2021, Black Americans and American Indians/Alaska Natives had the lowest life expectancy among all racial/ethnic groups [5] and older Black Americans had higher mortality rates from conditions like kidney disease compared to white counterparts [87]. Frailty prevalence—an outcome physical activity can reduce—was 24.6% for Hispanic Americans, 22.9% for Black Americans, and less than 14% for other groups [7, 107]. Health disparities between Black and white participants in studies have also increased over the past two decades [73].

In this uneven landscape of health outcomes, digital voice assistants (VAs)[3] are becoming increasingly popular and may provide one way for older adults to engage with preventative health applications from home. As of 2017, nearly half of Americans and 37% of people 50 and older use VAs [76], through smartphones and standalone voice-activated devices such as the Amazon Echo (Alexa) or Google Home. These VAs have demonstrable value for supporting older adults with health-related activities such as medication management, health-related inquiries, and exercise [15, 19, 25, 54,

[1]Following prior work in HCI (e.g., [80]), we use José Muñoz's term *minoritized* [70] to highlight a power imbalance between a community and a social majority that may not necessarily stem from underrepresentation.
[2]In this paper when we use the term *preventative health* we refer to physical health as opposed to mental health.
[3]In this paper we use the phrase *voice assistant* because that has become a widely used term. We do not imply that these devices fulfill the role of an "assistant" and later describe the range of relations participants have with the device. We more closely mean *digital voice agent*.

56, 74, 93]. Pairing VAs with preventative health applications for exercise [75] could support homebound older adults but whether these apps can motivate exercise in minoritized groups is unclear. Furthermore, there are few studies that examine the intersection of race, disability, and accessibility, and researchers in the ASSETS community have called attention to this gap [32, 43]. We respond to this call with our work by providing rare longitudinal evidence of how compounding issues from aging, race, income, and disability shape the adoption of voice assistants for preventative health.

Specifically, we seek to understand how VAs can encourage Black, largely lower-income older adults with chronic conditions and mobility limitations to exercise at home. Prior work shows older adults generally favor voice interfaces but over time they often stop using VAs due to reliability concerns, lack of trust, and usability challenges [25, 30, 100, 120]. Many VA studies with older adults have focused on health information seeking using a VA device [11, 18, 45, 69, 85] and how older adults set up VAs [26]. Prior work on Black older adults and VAs has focused on speech recognition barriers, privacy concerns, and health information seeking, and highlighted device cost as a barrier for lower income communities [8, 20, 42, 45, 46, 55, 71, 99]. We expand this work through a long-term comparative clinical trial of a VA-based exercise program versus a paper exercise program with Black older adults with chronic conditions and/or functional limitations in a lower income community.

We collaborated with geriatric medical researchers[4] at a local university-run hospital conducting a six-month clinical trial of an exercise app (called EngAGE) on an Amazon Echo Show device. In this paper, we report on two qualitative studies conducted pre- and post-clinical trial guided by two research questions:

RQ1: How do Black older adults, with chronic conditions and functional limitations, *perceive* and *relate to* voice assistants and how do these perceptions and relationships influence voice assistant effectiveness for promoting preventative health?

RQ2: What *motivating factors* influence the decision of Black older adults with chronic conditions and functional limitations to exercise, and how is a voice assistant exercise app motivating compared to paper exercises?

In framing RQ2, our aim is not to re-establish what motivates exercise, which prior work has examined, but to test whether the motivational promise of a VA-based intervention holds for a population that health-informatics research has rarely reached: Black, lower-income older adults with chronic conditions and mobility limitations.

In Study 1 (N=15, pre-trial), we conducted interviews and focus groups with Black older adults that included live interactions with Alexa on an Amazon Echo Show device and a review of screenshots of EngAGE. In Study 2 (N=20, post-trial), we conducted interviews with clinical trial participants immediately after their six-month study period ended. All participants recruited for the studies reported having multiple chronic illnesses, in addition to difficulty leaving home, and mobility limitations.

In Study 1, we found participants felt they had motivational barriers and challenges to doing exercise in addition to concerns around the costs and adoption of new technology like a voice assistant. Participants also had differing perceptions about using Alexa, which impacted their willingness to use the device for health purposes. In Study 2, we found that a significant motivation to exercise comes from human social support, regardless of the use of a VA-based exercise app or paper exercise packet. Overall, we found that a VA could provide some additional motivation to exercise but only if the participant had a positive interpersonal relationship with the VA.

Our contributions to the ASSETS community are:

- We extend research on Black and lower-income older adults' VA use (e.g. [20, 40, 42, 45, 46, 71, 84, 88, 90, 99, 118]), showing heterogeneous social perceptions of the VA—tool, amusement, friend, other, and intruder—that impact health-related VA use.
- We examine whether VAs motivate Black older adults with chronic illness and/or functional limitations to exercise, identifying 11 motivating factors across four interaction levels (individual, human-artifact, social support, and research study). Across both trial arms, human social support outweighed the digital intervention, speaking back to the assumption in health informatics that digital tools are the primary motivational lever.
- We provide a rare long-term comparative HCI study of VA use by Black older adults in a clinical trial corroborating and extending shorter-term prior works ([20, 32, 42, 43, 45]). We also surface adoption barriers specific to this population, including recurring subscription costs and default advertising on the device.

2 Related Work

We review prior research on overall adoption of voice assistants by older adults, voice assistants in healthcare for older adults, and technology-driven preventative health maintenance, respectively.

2.1 Adoption of Voice Assistants by Older Adults

Researchers have investigated how older adults adopt voice-enabled technologies because these technologies avoid graphical and physical user interfaces that can challenge people with low vision and decreased dexterity (e.g., [6, 13, 53, 100, 106]). While older adults have favorable initial attitudes towards voice interfaces, studies have found significant barriers to sustained use of stand-alone devices like the Amazon Echo. One study of older adults who used voice assistants for over a year found many abandoned the device over time due to finding few beneficial use cases, concerns the VA might limit independence, and difficulty navigating use in shared spaces [104]. Similarly, a three-week field trial for older adults with the Amazon Echo Dot found a disparity between the perceived usefulness of the device for tasks such as reminders and actual use due to fears of unreliability [85]. Older adults also worry about being patronized or manipulated by VAs [50, 95]. Several studies have outlined breakdowns[5] in older adult–virtual agent systems

[4]These researchers are actively involved in clinical work.

[5]We use the term *breakdown* from the field of Science and Technology Studies to denote an aspect of a sociotechnical system that causes friction or does not work as intended; breakdowns often require maintenance or repair work (see e.g., [52]).

due to communication and maintenance challenges that can lead to non-use [45, 58, 85, 119]. For instance, VA requests require a particular type of structured language that can be challenging for older adults. Other scholars have investigated older adults' privacy concerns with respect to voice assistants and how this impacts adoption as well as how older adults set up voice assistants [14, 24, 26, 31, 50, 57, 95].

Despite this work, most research treats older adults as a homogenous group, ignoring their different age ranges and cultural backgrounds [81]. Notably, three review papers on older adult use of voice technologies [53, 79, 94] make little to no mention of race, ethnicity, or cultural background. This literature gap was also flagged by Sezgin et al. [94] who note that "*VA developers will need to consider the contextual setting for behavioral health interventions*".

Research on Black older adults' voice assistant use is still limited and mostly short-term. Harrington et al. [45] found that Black older adults searching for health information on Google Home voice needed to "code switch" and alter their language to communicate with the device since the device does not reliably process African American Vernacular English (AAVE). Similarly, Bosco et al. [16] studied Black older adults searching for health information on dementia and found that voice assistants should "*have a tone of voice that resembles African American and Black voices*" to be successful. Brewer et al. [20] studied how Black older adults conceptualized "AI fairness" in voice technology, unpacking how their participants envisioned AI-driven voice assistants that could be more inclusive in terms of speech patterns and content. Most closely related to our own work, Green et al. examined Black older adults' perceptions of VAs using focus groups and interviews for delivering a medical recovery curriculum and found that there are still privacy concerns around VAs and a lack of feeling of being represented in these devices [42].

Research on VA use by lower-income communities has also raised concerns over both the cost of the device and the Internet connection needed to run it [46, 71]. So et al. [99] conducted a study on health-focused voice assistants with older adults from a range of racial/ethnic backgrounds in a lower-income neighborhood and found that participants wanted a "non-judgmental" device that could securely discuss stigmatized topics including drug use, isolation, and dementia. Health data confidentiality was also a significant concern for participants [71, 99].

2.2 Voice Assistants in Healthcare for Older Adults

Prior research has studied how VAs might aid older adults in healthcare contexts [15, 19, 25, 54, 56, 74, 93] including health information seeking from home [18, 45, 69, 85] and hospital settings [11], trust in VA-provided health information [30, 44, 56], accessibility [86, 121] and medication management [67]. As with general VA adoption, researchers found older adults commonly struggle with usability limitations in VA healthcare systems [25, 120]. To address these limitations and barriers to use, some research used co-design methods with older adults and caregivers to create inclusive, accessible, and ethical VAs for health-related activity [51, 63, 99, 114].

Research on minoritized groups in a healthcare context is important given their greater negative health outcomes and barriers to care [5, 44, 73, 87]. VAs have the potential to reach people who cannot access in-person care [69] but they do risk reinforcing bias and stereotypes that harm particular groups [64]. Harrington et al. [44] and Green et al. [42] specifically document how Black older adults may not feel well represented by VA content.

Research on the use of VAs in healthcare for older adults on *preventative health*—activities that reduce the likelihood of future disease—needs to be expanded. Hu et al. conducted co-design sessions with older adults on VA well-being applications using an exercise-focused probe [51] and others have used co-design to leverage large language models (LLMs) for a health assistant for debriefs and medication assistance after doctors' visits or to enhance older adults' communication with doctors [66, 117]. Bickmore et al. tested an exercise-focused conversational agent with eight older adults over a two-month period, with participants having a generally positive view of the agent [10]. Sezgin et al. [94] also reported evidence VAs could decrease pediatric body mass index (BMI) z-scores, but there is not an equivalent study for older adults.

Within the ASSETS community, research on voice assistants and related assistive smart devices has focused on accessibility for people with disabilities, including strategies and opportunities for people with tetraplegia [36], barriers created by commercial VA guidelines for blind users [17], the gap between what blind and low-vision people want from smart devices and what the literature assumes [39], and use patterns in spinal cord injury rehabilitation [96]. This body of work demonstrates how communication breakdowns, reliability, and trust shape VA adoption across disabled populations. Our findings extend these insights to Black older adults with chronic conditions, while surfacing cultural and surveillance-related factors less visible in prior VA accessibility research.

2.3 Technology-Driven Preventative Health Maintenance

Outside the scope of voice assistants and older adults, researchers have conducted studies on how technology might promote preventative health maintenance. One body of research investigates digital tools for health behavior change, finding that most physical activity apps do not use many evidence-based behavior change techniques such as goal-setting or social support modeling [28]. HCI researchers have also evaluated user experience of these tools for people with chronic diseases [47, 92, 98], people in lower socioeconomic groups [113] or both [55].

HCI researchers have also evaluated how people plan and integrate exercise into daily life [115], how visualizations and social features can support intrinsic and peer motivation [2, 3, 29, 72, 110, 111, 116]. Others have sought to understand technology-driven tools for older adults' physical exercise (e.g., mobility) [12, 27, 59].

In summary, our work sits at the intersection of these three bodies of work. We extend literature on Black older adults' VA use which is mostly short-term and focused on health information seeking to a longer term preventative health context as part of a clinical trial. We expand beyond speech and cost barriers to examine interpersonal and cultural factors that influence VA adoption in a rare comparative study of VA use for exercise versus paper-based exercises for a population affected by compounding challenges owing to race, income, chronic illness, and/or mobility limitations.

Table 1: Study 2 Clinical Trial Groups With Information And Support Provided To Each Group

Resources Provided	Paper Group	Voice Assistant Group
Alexa Tip Sheet	Yes	Yes
Clinical Trial Team Support	Yes	Yes
Exercise Information	Paper Packet	EngAGE
Voice Assistant	Yes	Yes

3 Methods

All procedures were approved by our Institutional Review Board (IRB).

3.1 Research Context

We (HCI / Computer Science researchers) collaborated with geriatric medical researchers running a clinical trial since 2021 (Figure 1) of EngAGE[6], an exercise app for the Amazon Echo Show device designed for older adults. The app guides older adults through mobility exercises requiring no specialized equipment (e.g., toe stands or bicep curls with soup cans) using voice instruction and static images. Users can verbally indicate if the exercises feel too easy or difficult and the app adjusts duration and difficulty accordingly. If an exercise is rated as too difficult, an email is also sent to the care partner. All exercises were drawn from the National Institute on Aging (NIA)'s exercise programs [77] designed for safe independent home use.

The clinical trial recruited community-dwelling[7] participants over 65 in Chicago who identified as Black or African American, were living with two or more long-term illnesses, and had difficulty leaving home. Each participant was recruited alongside a designated care partner—a family member or friend in regular contact—to provide encouragement and reminders. Participants were randomly assigned to either the EngAGE group (Amazon Echo Show with the VA-based EngAGE) or a paper packet with the same exercises (the same exercises in print with a VA available for general use) as shown in Table 1. The paper packet was used for comparison as this is the current and default mechanism for providing older adults with information on exercises in this clinical setting. Both groups received an Alexa tip sheet and access to a full-time staff member for technical support. Health metrics were measured at baseline before the trial and at the end of the six-month trial period.[8]

Study 1 was conducted before the clinical trial started (March-August 2022) using focus groups and interviews to explore older adults' perceptions and motivations to use Alexa and the VA-based EngAGE for preventative health. Findings also informed the design of instructional materials on the voice assistant and EngAGE for the clinical trial.[9] Study 2 was conducted with the first cohort of clinical trial participants (May 2023-September 2024) (see Figure 1) immediately after participants completed their six-month trial period. This study answered the questions about what factors motivate older adults to exercise and whether a voice assistant or paper-based exercise packet is better for this motivation.

3.2 Study 1: Examining Perceptions of VAs and Exercise

3.2.1 Protocol and Recruitment. To answer (RQ1), we conducted focus groups and interviews with Black older adults and their care partners prior to the clinical trial. Sessions included the following components: interview questions, an interaction with an Amazon Echo Show device, reviewing screenshots of EngAGE, and a sketching exercise (full protocol is in Appendix A.1). Interview questions were structured to be asset-based rather than deficit-focused [25] and asked about participants' social relationships with others, previous technology use, and health-related activities. For the interaction exercise, participants read an overview of what Amazon's voice assistant does, set up the Amazon Echo Show device, and interacted with Alexa by asking sample questions from a provided "tip sheet" (e.g., *Alexa, what's the weather today?*). The full tip sheet is included in Appendix A.2. The interaction exercise allowed us to observe real-time challenges with VA setup and use to inform clinical trial instructional materials. In the last part of the interaction exercise, participants reviewed screenshots of EngAGE.[10] Sessions ended with a sketching exercise that asked participants to draw where in their home they would place the Amazon Echo Show and how they pictured Alexa; building on prior work eliciting mental models of technology through sketches, e.g., [33, 34, 49, 83, 97]. The remote participant watched videos of someone interacting with Alexa and EngAGE and created online drawings.

We recruited minoritized older adults (65+ years old) and their non-professional care partner (any age who spent at least one hour a week with the older adult). We placed flyers in a senior clinic[11] in a lower socioeconomic neighborhood with an Area Deprivation Index of 72%[12][60, 105] as well as at bingo events, grocery stores, and barber and beauty shops in the neighborhood surrounding the clinic; and used snowball sampling. Between March and August 2022, we conducted 9 sessions with 1-4 people that each lasted approximately 1 hour and were held in-person in a conference room at the clinic, except for one participant who asked to do a Facetime video call. Focus groups were used where possible to make the study tractable since it was generally difficult to recruit participants who could come to the senior clinic. See Table 2 for a full list of participants. Sessions were audio recorded, transcribed by Rev.com under a non-disclosure agreement, and participants received a $25 Target gift card.

Note, while best efforts were made to meet recruiting criteria, at least two participants either identified under multiple race categories or declined to report race and one participant who accompanied another older adult reported being under 65.

3.2.2 Participants. We recruited N=15 total participants who are listed in Table 2. Participants included 14 minoritized older adults, three of whom identified as care partners to other people as well

[6] A full discussion of EngAGE pilot results is beyond the scope of our study. The medical researchers developed and successfully piloted the VA-based app, called EngAGE, prior to the start of our collaboration.
[7] i.e., not living in hospitals or nursing homes, but could be in seniors-only housing
[8] Data collection for the clinical trial was temporarily interrupted after our studies due to federal funding disruption. Final trial results are pending and out of scope for this paper.
[9] A full discussion of these materials is beyond the scope of the paper.
[10] Note: EngAGE was in the process of being updated at the time of Study 1 and thus unavailable for live testing.
[11] The medical team runs a senior clinic that serves adults who are 65+ years old.
[12] This index reflects that this neighborhood is more disadvantaged than 72% of the neighborhoods in Chicago.

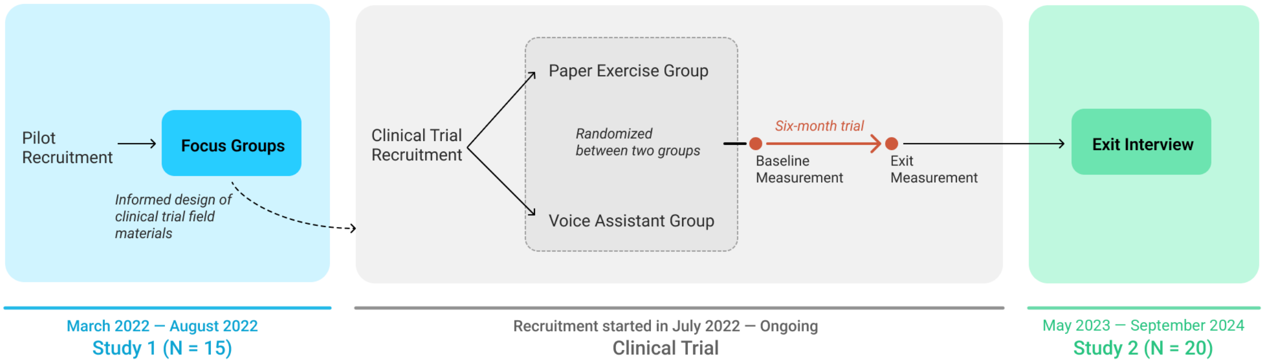

Figure 1: Timeline of our Study 1 and Study 2 and where they fit within the clinical trial period (this paper does not report clinical trial results, as the multi-year trial is ongoing).

Table 2: Participant Demographics for Study 1. Note: 1: Denotes participant is an older adult care partner. Participants 65 years old or older who identified as care partners are also considered older adults. 2: N/A indicates participant selected: Prefer not to answer 3: Participant selected the following: American Indian or Alaska Native, Black or African American, White 4: Household income 5: Participants with the same session number were in the same focus group.

ID	Gender	Age	Race/Ethnicity	Education	Income[4]	Occupation	Session[5]
1	F	75-79	Black or African American	Associate's/Some College	N/A	N/A	1
2[1]	F	<65	Black or African American	Associate's/Some College	N/A	N/A	1
3	F	85-89	Black or African American	Bachelor's degree	$60,000/year	Retired	2
4	F	75-79	Black or African American	Associate's/Some College	N/A	Retired	2
5	F	70-74	Black or African American	Bachelor's degree	N/A	Retired	3
6	F	N/A[2]	Black or African American	Master's degree	N/A	Retired	4
7	F	90-94	Black or African American	High school degree	N/A	Retired	5
8[1]	F	65-69	Mixed race[3]	Associate's/Some College	N/A	Retired sales consultant	5
9	F	70-74	Black or African American	Associate's/Some College	$1,200/month	Retired	5
10	F	75-79	Black or African American	Doctoral degree	N/A	Retired pastor	5
11[1]	F	75-79	N/A	Associate's/Some College	N/A	Retired	6
12[1]	M	75-79	Prefer to self-describe: Mixed race	N/A	N/A	Retired IT specialist	6
13	F	75-79	Black or African American	Bachelor's degree	$70,000/year	Retired teacher	7
14	F	75-79	Black or African American	Associate's/Some College	N/A	Retired sales, insurance	8
15	M	70-74	Black or African American	Associate's/Some College	N/A	Retired	9

but answered in their capacity as older adults. One younger care partner who accompanied one of the older adult participants also participated and answered questions based on their experiences with their older adult care partner. Most of our participants were women older than 75, retired, self-identified as Black or African American, and had at least an Associate's degree or some college. Many participants chose not to report annual household income. The median household income (2016–2020) for South Shore in Chicago where we recruited was $35,887/year. Approximately 82% of residents in this neighborhood have some form of Internet access (2016–2020), although the quality varies.

3.2.3 Analysis. We used a thematic analysis for qualitative data coding [89]. First, we collaboratively developed the codebook in Table 3 based on our focus group protocol, research questions, and review of the transcripts. Two members of the research team then coded all transcripts and sketches using the codebook (see Table 3). We did not calculate inter-rater reliability since we used the data coding as input to thematic analysis [68]. Sketches from the prompt *"Draw where you would put the Echo Show device in your home"* were included in code *"Location of voice assistant at home"*, and sketches from the prompt *"Draw what you think Alexa looks like"* were included in code *"Mental models."* In the second round of coding, we identified the main parent codes of interest and one member of the research team subcoded all excerpts extracted from those parent codes. After both rounds of coding, each team member produced a thematic summary of the parent code and its subcodes. All members of the research team reviewed the thematic summaries and derived the final emergent themes in the paper through discussion.

3.3 Study 2: Comparing Perceptions Of VA-based Exercise To Paper-based Exercise

3.3.1 Protocol and Recruitment. Interviews for Study 2 began in May of 2023, as participants completed their six-month clinical trial periods (Figure 1). All clinical trial participants were given a study-provided VA device as compensation. We developed two interview protocols for each trial group (paper exercises and VA-based EngAGE) (Appendix A.4 and Appendix A.5) to identify the

Table 3: Codebook for Study 1. Note: 1: Sketches from the prompt "Draw where you would put the Echo Show device in your home" analyzed under this code 2: Sketches from the prompt "Draw what you think Alexa looks like" analyzed under this code.

Code	Code Description
Communication with friends & family	Current social relations and technologies used to keep in touch
Communication with doctor	Technologies used to talk to doctor
Physical preventative health	Physical activity, nutrition, source of preventative health info
Mental preventative health	Activities to stay mentally active
Medical concerns	Non-preventative health concerns and information sources
Current tech use & experience	Current devices used and frequency of use
Help with tech	Who helps set up and answer questions about technology
Previous voice assistant experiences	Prior interactions with voice assistants
Privacy concerns	Any privacy concerns regarding voice assistants
Feelings	How did participants feel about interacting with Alexa
Feelings of friends and family	Friends and family feelings about voice assistants (perceived or actual)
Non-use	Specific tasks participants would not use a voice assistant for
To what extent use in future	In general, perception of future use
Relationship to Alexa	Characterizations of Alexa and participant relationship to the personality/device
Feelings about exercise application	Specific thoughts about the EngAGE program
Interaction breakdowns with Alexa	Examples of breakdowns when participants try out Alexa during focus group
Location of voice assistant at home[1]	Where place voice assistant in the home
Outlook on life/aging	General thoughts on life, aging, philosophy, etc. that impact views on technology
Mental models[2]	Mental models of voice assistants

Table 4: Participant Demographics for Study 2. Note: 1: P3 was in both Study 1 and Study 2.

ID	Clinical trial group	Gender	Age	Race/Ethnicity	Education	Indiv. Income (year)	Occupation
16	EngAGE	F	70-74	Black or African American	Master's degree	$0	Retired
17	EngAGE	F	65-69	Black or African American	Associate's degree	$40,000	Retired
18	EngAGE	F	70-74	Black or African American	Bachelor's degree	$60,000	Retired
3[1]	EngAGE	F	85-89	Black or African American	Bachelor's degree	$50,000	Retired
20	EngAGE	F	70-74	Black or African American	Bachelor's degree	$24,000	Retired
21	Paper	M	65-69	Black or African American	Some high school	$26,400	N/A
22	EngAGE	F	75-79	Black or African American	Some middle school	$10,968	Retired
23	Paper	F	80-84	Black or African American	Bachelor's degree	$75,000	Retired
24	Paper	F	65-69	Black or African American	Some college	$13,000	N/A
25	EngAGE	F	65-69	Black or African American	Some college	$0	N/A
26	Paper	F	65-69	Black or African American	Some college	$30,000	Retired
27	EngAGE	F	70-74	Black or African American	Some high school	$16,800	Retired
28	Paper	M	65-69	Black or African American	Some college	$84,000	Retired
29	Paper	F	80-84	Black or African American	Master's degree	$0	Retired
30	EngAGE	F	70-74	Black or African American	High school	$16,668	Retired
31	Paper	F	65-69	Black or African American	Some college	$10,020	Retired
32	Paper	M	70-74	Black or African American	Associate's degree	$14,400	Retired
33	Paper	F	65-69	Black or African American	Some high school	$10,968	Retired
34	Paper	F	65-69	Black or African American	Some high school	$10,092	N/A
35	EngAGE	F	65-69	Black or African American	Some college	$20,000	Retired

motivating factors for exercise, and the role the VA played (RQ2). The EngAGE group protocol included additional questions about features that only existed on the EngAGE (e.g., *Did you use either the reminder or tracking system?*) and about interactions that are only possible with a VA device (e.g., *Is there anything you wouldn't say with Alexa in the room?*).

All interviews were conducted by phone, lasted no longer than 30 minutes, were audio recorded, and occurred from May 2023 to September 2024.[13] Similar to Study 1, we transcribed the interviews with Rev.com using a non-disclosure agreement.

[13]Every participant was in the trial for six months total, but start times varied.

3.3.2 *Participants.* We recruited N=20 participants from the clinical trial pool (see Table 4). Participants' self-reported chronic illnesses included high blood pressure (N=16), back pain (N=9), diabetes (N=8), and osteoarthritis (N=8) (see Appendix for the full list). All but six participants had some higher education; most were retired women in their 60s and 70s with individual income ranging from $0 to $84,000 per year, though we note that 15/20 participants made under $35,000 per year. All identified as African American or Black as required by the clinical trial. One participant, P3, took part in both studies with no noticeable differences in responses.

3.3.3 *Analysis.* We followed the same two-round thematic analysis process as Study 1 with a team of three researchers [89]. First, two members of the research team developed and refined our codebook, based on the interview protocol, by each coding three of the same transcripts and ensuring agreement in codes (see the codebook in

Table 5). Then, each team member coded a third of the transcripts as primary coder and a third of the transcripts as secondary coder. During the coding process, the entire research team met regularly to discuss the codes and ensure agreement. In round two, the team performed subcoding on excerpts from parent codes of interest and wrote thematic summaries. Based on these summaries and discussions, we identified a list of factors motivating participants to exercise and grouped these into interaction levels (Table 6).

4 Study 1 Findings: Sociotechnical Factors Influencing Voice Assistant Adoption For Exercise

In Study 1, we present findings on sociotechnical factors influencing VA adoption for preventative health and the distinct interpersonal relations participants described with Alexa that shaped their willingness to use the device for exercise.

4.1 Factors Influencing VA Use For Exercise

Participants' attitudes toward exercise, new technology adoption, and EngAGE all shaped their perceptions of VAs for preventative health.

4.1.1 Understanding Barriers And Motivation To Exercise. Older adults in our study explained that exercise could be difficult or painful due to existing conditions (e.g., a prior stroke or fall) and risk of injury. P14 captured this sentiment: *"Since the stroke, I have a lot of back problems. So, I feel in my own self, at 76, I'm doing well. I have the cane when I feel really unsteady, but to hurt myself to maybe progress an inch, to me, it's not worth it."*

Getting out of the house was also a challenge made worse by the COVID-19 pandemic. Many participants did not drive, had limited walking range, and expressed concerns about falling and being a target for theft given the crime levels and frequent shootings in the neighborhood. P1 told us how losing access to a community center during the pandemic had ended a robust exercise habit: *"The pandemic closed the center down... So, I exercised two hours a day, five days a week until everything closed up. Now I haven't gotten back into nothing."* The community center mattered not only as an exercise space but as a place to socialize where participants felt physically safe.

Among those who exercise regularly, motivation came from two sources: concrete benefits like weight loss and a lifelong, innate drive to be active. P11, a woman in her late 70s, explained: *"I realized in my head that if I keep this weight on and keep getting heavier, I'm going to have more problems."* P3, at 86, described embracing aging with joy: *"I am unlimited and untethered and highly adaptable."* Participants with this positive outlook were more consistently active even though they faced barriers like lack of usable outdoor spaces.

4.1.2 Costs and Cognitive Load of VA Adoption. Most participants used technology primarily for communication—TVs, tablets, and smartphones—and seven had some prior exposure to VAs through smartphones and streaming services or through standalone devices like the Amazon Echo Dot. Many expressed that new technologies carry prohibitively high adoption costs in time and cognitive effort. With VAs specifically, participants struggled with the syntax and timing Alexa required such as beginning with "Alexa", not pausing too long, and not asking follow-on questions. As P5 put it after working through the structure: *"You should just be straight with her"*. Participants also sometimes needed to shift their language from African American Vernacular English (AAVE) toward what is considered "Standard English" to be understood (as noted by others [42, 45]).

Financial costs were an equal barrier. When P14 learned the Echo Show costs were over $200, she said: *"Well, see for people on social security, now that would be an extravagance. It would be a good thing to have, but that is more than [pause]. I'm driving a 22-year-old car. So, it just explains to you what I feel about money. I'm very frugal."* Beyond the purchase price, the Echo Show requires recurring subscriptions for many features (e.g. songs, skills, and services) and by default displayed ads, including for online gambling, on its home screen which the research team had to disable before sessions.

These costs meant participants were unlikely to adopt these new technologies unless they addressed a clear unmet need. P14 captured this sentiment when explaining why she never used Zoom to contact her doctor: *"I've never even had a Zoom call. I don't even know what it looks like. So, I would be groping and that would lead to anxiety. And why bother? Just get on the phone."* This suggests VA adoption by older adults in a minoritized community is more likely when the use case is well defined, the learning curve is manageable, and the financial costs are low.

4.1.3 Attitudes Toward Using VAs For Exercise. Interest in using a VA for exercise mapped onto participants' existing attitudes towards exercise and technology. Among enthusiastic participants, P4, who already owned an Echo Dot, saw the VA and EngAGE as a way to impose structure on her exercise habits: *"I would love [using EngAGE] because like I said, I need a ball. If I do it myself, sometime I say, oh, I'll do it later. I'll do this. But if I had that, I could just set it and do it."* P3, in the same focus group, was immediately ready to try it: *"Well, I'm ready for EngAGE. How do I put EngAGE on here? I'm ready to exercise."* She saw exercise as the core value proposition of the VA, noting it was better than her existing routine watching exercise DVDs.

Not every participant was enthusiastic about EngAGE. P1 and P2, a parent and her adult daughter/care partner, disagreed on the VA's value. P2 felt it *"would have been good with COVID when [the center with in-person exercise classes] was shut down,"* but P1 felt she would *"still exercise"* through daily household activities regardless. P5 illustrated a different barrier, technology avoidance, recounting that she once bought a Wii for exercise: *"You know, you see it advertised. Oh, I could use that. And you get it. I couldn't even tell you if everything was in the box. Because I never opened it."*

Overall, participants who lacked a reliable exercise routine were open to the VA while those with existing routines or reluctance to use new technology saw less benefit in adopting it.

4.2 Perceptions of the Alexa Voice Assistant

In Study 1, we also examined participants' relationships with Alexa and how these shaped willingness to use the device for preventative health. The context of use informed which relationship type was foregrounded. For instance, P11 characterized the VA as a "peeping tom" when discussing its voice detection and recording but as a "beautiful woman" when describing its technological capabilities.

Table 5: Codebook for Study 2

Code	Code Description
Prior exercise habits	Types of exercise the participant engaged in prior to the study
Motivation to exercise	Reasons for why the participant felt motivated to exercise and stay healthy
Challenges to exercise	Reasons why it was challenging for the participant to exercise
Routine	What kind of routine the participant had for using the EngAGE app or paper exercises
Feedback on study exercises	Comments related specifically to the exercises/content provided in the study
Feedback on study	Miscellaneous study feedback not related to the exercises/content
Care partner relationship	What was the relationship of the study-designated care partner to the participant
Care partner support	The kinds of support (or lack of support) provided by the study-designated care partner
Non-care partner support	The kinds of support provided by someone other than the study-designated care partner
Future exercise plans	How does the participant envision their exercise routine going forward
Voice assistant uses	Uses for voice assistants (including Alexa) outside of the exercise program
Voice assistant opinions	Opinions about voice assistants (including Alexa) outside of the exercise program
Other motivating factors	Motivating factors not captured in existing codes

While prior works have touched on viewing Alexa as a "toy" [18, 44, 104], we focus on the full range of *relationships* participants developed with Alexa over six months and how these shaped health-related VA use.

4.2.1 Alexa as Tool For Health. Some participants saw the VA as a **tool** to accomplish preset goals or tasks consistent with seeing the VA as a machine (Figure 2). Key VA uses participants talked about included setting timers, alarms, video calling, voice-to-text, and search, several of which participants explicitly connected to exercise, diet, and health.

Participants who wanted to use the VA for exercise were interested in the VA's ability to help them **form and keep up exercise habits**. P3 envisioned it reminding her of exercises she should *"do before leaving the bed,"* catching her *"between the time [she] open [her] eyes and before [she] jump[s] out of bed"*. P5 similarly thought it would be *"encouraging for Alexa to remind"* her to go on her daily morning walk and P15 hoped he could use it as a *"timer for high intensity exercise."* Maintaining an exercise schedule structure was an important unmet need participants imagined the VA and EngAGE could fill.

The ability to **search for information** on the VA was the second key tool-related use participants saw for the VA. P5 imagined looking up exercises to do indoors during bad weather, P10 wanted to *"research on [her] own"* on her medication, and participants also envisioned using it to search for recipes to help *"track and maintain"* food intake under *"diet care constraints"* (P15). Other health applications included emergency and non-emergency hands-free communication with medical professionals (P2, P14) and using brain teasers to keep the mind active (P11). Participants felt the VA would be useful for retrieving and learning information and be a reliable and trustworthy tool for health and exercise education. Viewing Alexa as a tool can potentially enable older adults to operationalize preventative health goals.

4.2.2 Alexa as a Means To Or An Amusement Itself. Participants were accustomed to using technology (TVs, smartphones, music players, DVD players) for entertainment and saw the VA fulfilling a similar role by **integrating it with the technologies they already use**. P5 imagined using voice commands as a remote control, P3 wanted to use the VA to *"play [music] that's on [her] phone."* Though not directly health-related, these examples show that participants were willing to incorporate the VA into existing habits and interests which could extend to exercise.

For several participants, the VA was more like a **toy or game**. P6 said she could *"get lost at this thing playing with it"*. P4 tested its limits by asking *"stupid questions,"* like *"Alexa, where my car at?"*. P11 was drawn to games accessible through the VA such as crossword puzzling, stressing the need to *"exercise the brain"* by using its *"muscles."* This interest in using the VA for memory and cognitive challenges shows participants could envision entertainment-focused VA use for health benefits. Viewing Alexa as an amusement may offer preventative health benefits by keeping older adults mentally engaged.

4.2.3 Alexa as Friend, Lover, and Family Member. While some participants' VA uses were task-oriented, in other cases the participant-VA relationship was the most influential aspect. Figure 2 exemplifies this contrast: P11 drew Alexa as a static machine while P15 drew Alexa as a woman waving. Participants sometimes referred to or interacted with the VA as they would in a **friendship, family, or romantic relationship**. P3 called Alexa her *"good friend"*, feeling it acted in her best interests, and for P14, the *"awesome"* relationship was significant since she is *"a person living alone, having no contacts, doesn't do much and doesn't see a lot of people."* Some interactions crossed into romantic territory, mostly as a joke: P15 considered adopting the study's VA in addition to his existing VA, Siri, and remarked he was *"trying to be monogamous as much as possible"*.

Participants' attitudes toward a VA taking on a **familial role** were more complex. P3 described the VA as a parental figure: *"[Alexa is] your mommy getting after you as a little kid and she got a good mommy voice"*. In contrast, many participants referred to Alexa as a *"girl"* and questioned its intelligence. P1 said the VA was *"acting like a five-year-old"* when it kept speaking even after being asked to stop. P5, similarly, was not successful in asking the VA more complicated questions, concluding that, to communicate with it, you needed to simplify your asks. The infantilization of the VA meant some participants approached it with tenderness too. P5, after her "straight" talk comment, called the VA "cute" and P3 described her VA as one of three members of her inner circle: *"that's my husband and this girl."* The familial role of the VA is more nuanced than the friend or romantic role since it introduces power dynamics that call

Figure 2: Participant sketches in response to the prompt "Draw what you think Alexa looks like". On the left is P11's sketch of Alexa as a machine. On the right is P15's sketch of Alexa as a woman waving.

the VA's ability and competence into question which could undermine its helpfulness for health goals. Therefore, viewing Alexa as a friend, lover, or family member could offer older adults benefits of companionship for preventative health but could also backfire if power dynamics are perceived to be undercutting Alexa's help with health goals.

4.2.4 Alexa as "Other". Some participants found Alexa **unrelatable** akin to a stranger or an other during the live focus group interactions. P3 and P4 asked Alexa for *jerk chicken* recipes and received generic chicken recipes instead:

> *P3: Alexa, find me a recipe for jerk chicken.*
> *Alexa: Finding some chicken recipes. Okay. For chicken, here's a few recipes.*
> *P3: Chicken noodle soup.*
> *P4: That ain't jerk chicken.*
> *P3: I know, but she don't understand good. She said chicken.*
> *P4: Well maybe you use just jerk, the word, jerk chicken, oh, now she doesn't-*
> *P3: She doesn't know jerk. She doesn't know what a jerk is. Alexa, do you know what a jerk is?*
> *Alexa: As a noun jerk can have a few meanings. One, a quick sharp thrust twist throw, or the like, a sudden movement. Two, a spasmodic, usually involuntary muscular movement at-*
> *P3: See? Okay. So, she doesn't know about jerk other than the regular meaning of jerk, a quick movement. So, see, she doesn't know about that.*

Alexa failed to recognize "jerk" as a Jamaican cooking style, leading P3 and P4 to conclude that the device was not designed with their cultural background in mind.

P15 found it *"very frustrating"* trying to communicate with Alexa not because of what he said but how he said it. *"They not really set up for people of my ethnicity,"* he remarked, *"it doesn't recognize the tonality or whatever it is"*. He tested this theory by repeating a spelling question several times:

> *P15: Alexa, what's the definition of cantankerous?*
> *P15: Mm-hmm. Alexa, what's the definition of cantankerous.*
> *P15: Alexa, how do you spell cantankerous?*
> *Alexa: I'm not quite sure how to help you with that.*

This left P15 convinced the device could not understand him and left him disinterested in using it for any purpose including health.

P5 encountered the same cultural gap when Alexa responded to a joke request with: *"Why did the golfers get kicked out of the library? Their pants were way too loud."* This golf reference left the participant puzzled and wanting to know more about the background of the designers of the VA to see if that might explain the joke. When P5 asked Alexa that question, it responded with an unsatisfying joke that did not reveal any new information to her. These barriers were noticeable to participants and eroded trust in the relationship. In fact, it made some participants, such as P15, disinterested in using the VA in any context, including for exercise or health promotion. In essence, viewing Alexa as an "other" makes it less likely that an older adult will invest in the relationship to improve their health since it does not integrate into their everyday lives. It also suggests that this does not just make VAs frustrating but that being sensitive to cultural representation is a precondition for adoption.

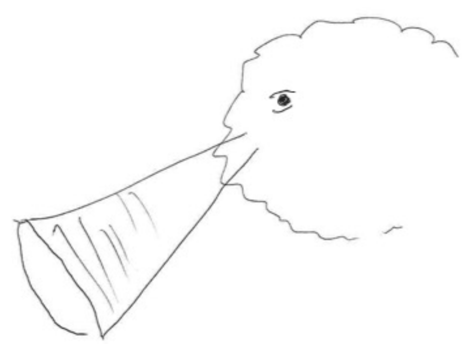

Figure 3: P12's sketch of a cloud looking in a telescope for the prompt "Draw what you think Alexa looks like" that he labeled *Spy in the Sky* to show that he felt cloud-based Amazon Alexa devices were spying on users.

4.2.5 Alexa as Intruder. Some participants described fundamental objections to the VA that prevented any positive relationship with it; seeing Alexa as ***"an intruder"*** (P1). P14 had moral objections: *"The AI thing, I hate it. Just something about it. It's so unnatural that we're doing too many things that God did not intend for us to do."* P12, part of a married couple, feared being hacked and surveilled by the VA device and called the VA a *"spy in the sky"* (illustrated in Figure 3). P1's concerns were more personal in that their data *"could be unloaded by any grandchild, which makes me feel very icky."*

Some participants who retained interest in using a VA described physical mitigation strategies. P1 planned to cover the device with a brown paper bag during private moments: *"If I was doing something, I'd have to take a brown paper bag, open it up, turn it upside down, and put it over Alexa for my own privacy"*. For others, surveillance concerns were paramount. P1 *"would not allow this in her house"*, P15 was *"not going to go out and buy [it], for [it] to come in and spy on [him]."* and P12 refused to interact with the Echo Show at all stating *"I'm not recording my voice."*

When participants framed Alexa as an intruder, they were the clearest of any relationship type in stating that the VA's role in their lives was unacceptable and, therefore, they were not willing to use it for exercise, health, or any other use. In other words, viewing Alexa as an intruder makes it less likely that an older adult would view the tool as helpful for preventative health, rather than a tool for potential unwanted surveillance.

Study 1 showed that participants' attitudes towards exercise and new technology shaped their willingness to adopt a VA for preventative health. Cultural barriers, such as Alexa not understanding AAVE or culturally specific requests, frustrated participants but did not cause them to give up on the device entirely. Privacy concerns were more decisive: some participants could overlook or manage them, but for others the threat of surveillance outweighed any benefit.

5 Study 2 Findings: Alexa Voice Assistant vs. Paper Packet Exercise Routines

To address RQ2, we compare factors influencing exercise motivation across the VA and paper packet groups, organized into four interaction levels: 1) individual, 2) human-artifact interaction, 3) social support interaction, and 4) research study interaction (see Figure 4 and Table 6). Together they underscore that the entire sociotechnical system, not just the exercise artifact, was important for motivating participants to exercise.[14] This finding highlights again what we found in Study 1: that participants' perceptions about the device and Alexa's personality influence their willingness to use the VA for health purposes. For those who had positive experiences with the VA, it was a tool to amplify motivation to exercise but could not replace the other factors in the sociotechnical system required to support older adults in adopting an exercise routine.

5.1 Individual Factors Influencing Exercise

Individual motivating factors were personal characteristics that made participants more likely to exercise (Level 1 in Figure 4). Both factors—intrinsic motivation and lack of health challenges—were important across the VA and paper packet groups. The VA device did not influence either individual motivating factor.

Participants in both groups who exercised consistently described lifelong self-motivation as a key factor to exercise. P3 (VA group) said: *"I've always told myself from a young woman that I'm total, whole, complete, unlimited, and highly adaptable. So, your body will give you back that if that's what you tell it."* P28 (Paper group) put it plainly, *"I tell somebody if they want to get into the program to really get themselves together, self-motivation is the key to anything."* Conversely, even intrinsically motivated participants could be stopped by health setbacks such as surgery, arthritis, bad backs, or knees. P16 (VA group) said health issues throughout the trial *"got in the way of my doing the EngAGE and other exercises,"* and P21 (Paper group) described being *"in so much pain. And I mean, my knees, my back, you name it. I was in so much pain and it was hard to do it"*.

5.2 Human-Artifact Factors Influencing Exercise

Motivating factors at this level derived from interaction with the exercise artifact—EngAGE on the VA or a paper packet with the same exercises (Level 2 in Figure 4). Some motivating factors were present in both groups; others were specific to VA interaction where Alexa's personality and interactivity could be positive motivators and privacy concerns could be negative factors.

5.2.1 Exercises Feel Achievable. Participants in both groups were motivated to continue with the exercise program because the exercises felt within their physical capacity. P27 (VA group) said *"It wasn't strenuous or none of that. It was something that I could do. So, I actually liked it."* P21 (Paper group) had initially worried the exercises would be too hard given his arthritis and pain but found them surprisingly manageable: *"when I did (the exercises), I was amazed. I was like, 'Wow, that is real smooth."'* An advantage specific to EngAGE was the ability to verbally adjust the difficulty of the exercises. P3 noted the app calibrated over time: *"When I first started out... I answered [the exercises] were too difficult. And as I progressed... it got easier, so I was always just right."* No paper group participants mentioned the ability to vary the difficulty of the exercises, suggesting that the VA enhances this motivating factor.

5.2.2 Noticeable Health-Related Improvements. Both groups were motivated by improvements they attributed to the exercise program such as weight loss and better mobility. P30 (VA group) said losing weight made her want to keep going: *"I'm glad I started, because I did lose some weight, and I was very proud of myself. I was like, 'I actually want to get this exercise done."'* P23 (Paper group) exercised to prevent stiffness from arthritis. Notably, the exercises were not designed for weight loss and several participants reported paying more attention to nutrition during the study suggesting that a healthy exercise routine may prompt broader health behaviors.

5.2.3 Voice Assistant Device Interactivity. Within the VA group, interactive affordances of the VA device—such as the voice prompts and screen images—were helpful for some. P18 strongly endorsed the VA saying, *"I liked it, the screen showing you what you're doing at a particular time, and then Alexa reminding you how to breathe because I forget that, when you're supposed to breathe in and when you're supposed to breathe out. I get confused and then her talking*

[14] Note: the clinical team's full analysis is pending trial completion.

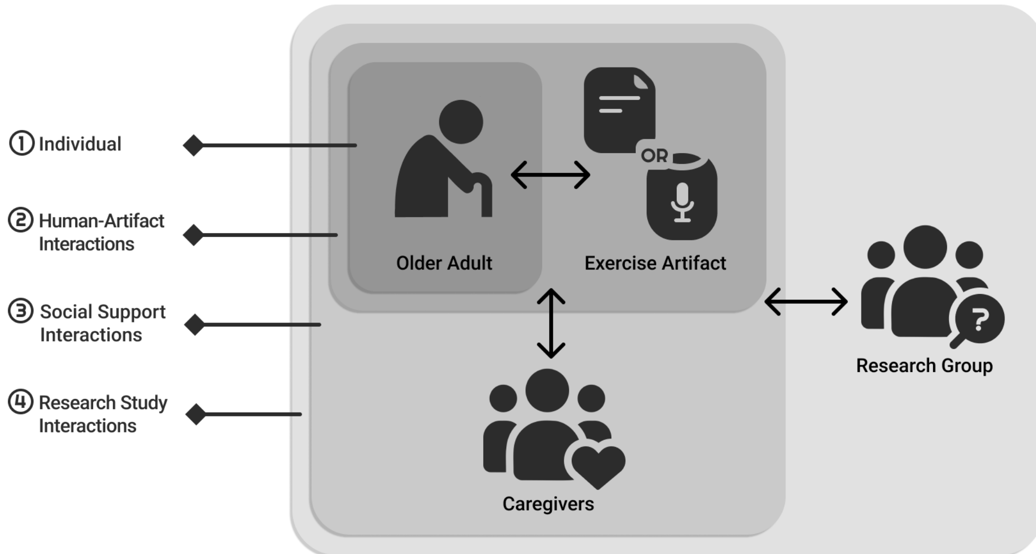

Figure 4: Interaction levels experienced by clinical trial participants

Table 6: Study 2: Motivating factors that influence a participant's exercise behavior

Interaction level	Factor	Description
1. Individual	Intrinsic motivation to exercise	Personal belief that exercise is important
	Lack of health challenges	Participant in good physical state
2. Human-Artifact	Exercises feel achievable	Exercises are not too challenging for participant
	Noticeable health-related improvements	Participant felt better after doing exercises
	Voice assistant device interactivity	Interactivity affordances such as voice commands
	Alexa's personality	How participants felt about interacting with Alexa
	Voice assistant privacy	Concerns about the privacy and security of VA data
3. Social Support	Care partner support	Support provided by designated care partner in study
	Broader social support	Support provided outside of designated care partner
4. Research Study	Habit formation due to clinical trial structure	Exercise became a habit during clinical trial
	Technical support and comfort with technology	Technical obstacles overcome due to tech support staff

to you brings it back to me." Most VA group participants spent the default 30 minutes (the set time for the program) exercising following EngAGE's instructions. For example, P30 said, *"I just follow along with the instructions that [Alexa] tell me what I have to do and I just do it."* However, consistent with findings in healthy adult populations [65], simply providing a VA is not enough to motivate users to exercise.

5.2.4 Alexa's Personality. Consistent with Study 1 and the perceptions of the VA (e.g. in Section 4.2.3), participants had mixed views on Alexa's personality, which was important because most considered Alexa and EngAGE as one experience. P16 found Alexa amusing, *"And it is funny because if I whisper, she whispers right back at me."* P3 was lukewarm on Alexa's personality but motivated by the novelty of learning a new technology: *"I know how to use the television, I know how to use Zoom. My brain is still wanting to learn. So, if there was something else given to me, I'm very anxious to learn something."* For P25, Alexa was an active annoyance: *"I wasn't crazy about EngAGE... I rather somebody just give me the exercises to do and then just let me do them rather than her talking all the time because that's a distraction and an irritant for me."* Most participants fell somewhere between neutral and lukewarm with personality perceptions shaping exercise engagement with EngAGE and the VA.

5.2.5 VA Privacy Concerns. Many VA group participants were concerned about the device always listening and having a camera in their home. P27 made a representative comment saying, *"[Alexa] hear things that she ain't got no business hearing. Then, she might repeat something, because somebody said something, but not necessarily talking to her... If there's something going on, and the police is called, she going to tell everything she knows."* In contrast, others felt they had nothing to hide and were unconcerned. As in Study 1, participants unwilling to have a VA at home self-selected out of the clinical trial entirely, meaning privacy concerns shaped who participated as much as how they participated.

5.3 Social Support Factors Influencing Exercise

Care partners—chosen by participants from family and friends—were critical exercise motivators in both groups. Most were children or grandchildren and a few were neighbors (Level 3 in Figure 4).

5.3.1 Study Care Partner Support. Care partner support was a major motivating factor in keeping participants on track and motivated to exercise across both groups. P26 (paper group) said her care partner *"kept me dedicated to (the exercise program) because I knew he would ask me about it. So, I didn't want to lie, so I would just go ahead and do it."* When P33's (Paper group) care partner moved away mid-study: *"The motivation wasn't there anymore."* Having a trusted partner was important: P25 (VA group) said, *"Because (my care partner) knows me and it wasn't like it was a stranger or someone distant. When she says things to me, she wants me to do better."* P30 (VA group) described her son checking in after every session: *"He was just always asking me, 'Mama, how did the exercise go or did you enjoy doing it?' I just say, 'Yeah, it was fun.'"* These findings show that even with a conversational agent available, Alexa and EngAGE did not replace the need for human social support and motivation.

5.3.2 Broader Social Support. Beyond designated care partners, close family and friends were critical motivators and these included walking groups, gym friends, and family nutrition support. As noted in Study 1, community exercise classes were a strong motivator before the pandemic and losing access to the community center halted exercise for some. This emphasizes the fact that a VA can augment a routine when in-person options are not available but cannot replace community-based activity as a motivating force.

5.4 Research Study Factors Influencing Exercise

The clinical trial structure itself was a source of motivation through both the habit-forming routine it created and the technical support it provided (Level 4 in Figure 4).

5.4.1 Habit Formation due to Clinical Trial Structure. The six-month clinical trial, regular staff check-ins, and structured exercise materials led participants in both groups to develop new exercise habits. P31 (Paper group) said the trial gave her *"some structured time to do things,"* and *"I don't think that you can do something like this for such a length of time and then all of a sudden just stop it."* In the VA group, P20 also described building a routine around the app: *"It was good to have that routine... I know I got to do Alexas and then if I miss, I said, 'Oh, I didn't do my Alexas yet. I got to do them by a certain time.'"* Though the clinical trial imposed no hard exercise requirements, the structure was a meaningful motivator for habit formation in both groups.

5.4.2 Technical Support and Comfort with Technology. Participants' comfort level using the VA device was significantly bolstered by help from a full-time clinical trial staff member who acted as on-call technical support for participants. When the trial ended, participants had to transfer the device to their personal Amazon account, a barrier that stopped some from continuing. P16 found she simply could not complete the transfer: *"Even after [the clinical trial account] was gone... I tried to, dang, I can't do this anymore. So, I went to do [the exercise program], but I couldn't."* Paper exercises held an advantage here since motivated participants could continue without any technical assistance while VA users without support often could not.

6 Discussion

Across both our studies, we found that sociotechnical factors and relational types shape VA adoption for health and that the VA was an additional motivator for some participants beyond the paper group. We situate our findings in research on "contextual factors" affecting health technology adoption, including costs (Section 6.1), culture, social context, race/ethnicity, and access [32, 35, 43, 88]. Our work extends HCI research on understanding how technology is embedded in social systems including work on interpersonal relations with VAs (e.g. [40, 84, 90, 118]) and social support in health technology interventions (e.g. [46]).

6.1 Reducing the cost of adoption for minoritized older adults

In Study 1 and Study 2, financial and learning costs of VA adoption were prohibitive for many participants, consistent with prior work on Black older adults and VAs [42]. We extend findings on device cost as a barrier [71] by identifying additional financial costs of digital assistants such as recurring subscription fees, add-on features (e.g., ad-free experiences), and the potential financial harm caused by default ads shown on the Echo Show home screen (e.g., for online gambling). Costs fall unevenly so expensive stand-alone VA devices risk worsening health disparities if lower income users cannot access them. Health applications like EngAGE that are only available on stand-alone devices compound this problem by requiring a hardware purchase rather than leveraging smartphones that older adults already own.

The learning cost is an equivalent barrier. Participants were willing to learn smartphones and tablets because the value was clear for entertainment and being able to communicate with family and doctors. Participants who were disinterested in using a VA for preventative health did not see a compelling use case which others have noted can be a barrier for older adults outside a health context [85, 104]. This points to a design imperative: health technologies must center capabilities that older adults value to make it worthwhile for them to expend effort learning how to use a new tool. Our findings suggest that social connection could be one value addition. Participants who exercised regularly valued doing so with others in community settings. Applications that combine preventative health with community connection may better justify the learning investment. EngAGE offers the ability for care partners to send messages to users, but initial participant reactions to this feature were mixed because some worried that it would be logistically challenging or that they might disappoint their care partner if they failed to exercise. More research is needed on how best to incorporate social connection into health applications and to what extent this makes older adults feel it is worthwhile to overcome the learning costs. The Peloton app [1] offers one model worth studying in that it successfully allows users to attend virtual exercise classes with others and follow the progress of people in their network.

6.2 Designing participant–voice assistant relationships with Black older adults

Black older adults' relationships with Alexa shape how they might use and trust VA-based health applications. Prior work has framed interpersonal relations with VAs as a dichotomy—treating the device as either a person or an object [84]—and found that anthropomorphized VAs are often seen as a friend [40, 84, 90, 118]. While these studies have not examined the role of racial/ethnic identities in older adults' VA perceptions, other researchers have shown that VAs like Alexa are typically designed as white and female personas and do not accommodate African-American Vernacular English [82, 91], prompting Black users to "code switch" or change their style of speaking when talking with VAs [20, 45]. Our longer-term study confirmed these findings: our participants felt that Alexa was not designed with them in mind, often misunderstood their requests, and required them to shift their speech to be understood.

We extend prior work by showing how these relational types shape VA use for preventative health specifically. Beyond the friend versus object dichotomy, our participants described *tool* or *amusement* relationships. "Amusement" is a particularly useful design lens for VA preventative health apps: many retired participants, often homebound due to physical limitations, enjoyed Alexa as both a diversion and a tool to learn a new skill. Although prior work notes that the cognitive demands of new technologies can deter older adults [58, 85, 119], our participants enjoyed the experience of exploring and learning a new technology to keep their brain sharp and often used it as a talking point with younger family members [101]. We suggest that VA health applications designers incorporate the entertainment value and inspire curiosity to motivate ongoing engagement with the VA.

The *other* relationship underscores cultural gaps between the device and Black older adults. Misalignments, such as Alexa's inability to provide a jerk chicken recipe or jokes about golf (a sport associated with white, high-income groups), left participants alienated and frustrated. Echoing prior findings [8, 42, 44], we suggest that culturally diverse VA personas could mitigate these issues. As AI advances in language and cultural adaptation, future research should examine how Black older adults' perceptions of VAs differ when the dialogue and content is more relevant. Compared with prior ASSETS work on voice assistants and accessibility [17, 36, 39, 96], the breakdown, reliability, and trust dynamics we observed appear to transfer across populations, while the cultural misalignments (e.g., unrecognized AAVE and cultural references) and concerns rooted in the history of surveillance of Black communities were more specific to our participants and shaped their willingness to adopt the VA for health.

A final relationship we identified is the *intruder*, based on some participants' concerns about privacy that have roots in the history of surveillance of Black people in the US. While previous work has examined older adults' trust and privacy attitudes toward technology [14, 31, 37, 38, 41, 50, 57, 62, 95] and how these may or may not impact voice assistant use [61], these studies were either majority-white participants or omitted racial identity. More recent studies [42, 45] and our longer term data together highlight how conscious consideration of race as a factor in VAs affects trust, because of participants' lived experiences of surveillance from the civil rights era to today when there is an ongoing incorporation of racial discrimination in new technologies [9, 21]. Designers should offer tangible privacy controls [4] such as physical or hardware-based controls (e.g., camera switches or removable microphones), to provide strong privacy guarantees to participants who may not trust software-based privacy solutions. Future research could examine how older adults from varying demographics (e.g., race/ethnicity, income, gender) conceptualize VA privacy and surveillance harms to address and mitigate these concerns.

Building on prior work [109], we argue that users' relationships with VAs are culturally situated and should be considered during design. For Black older adults, cultural contextual understanding and privacy assurances are foundational. Health or exercise suggestions that overlook cultural context or assume safe access to outdoor spaces or that use mainstream cultural references risk alienating the very users they are aiming to serve.

6.3 Human social support is a critical component of voice assistant preventative health application design for lower-income older adults

Social support was the most consistent motivating factor we found in Study 2 across both groups which was consistent with prior work showing older adults find significant gratification in social connections during health interventions [108, 112]. Care partner check-ins and exercising together with a care partner were strong motivators but technical challenges with the VA were a barrier with many participants relying on the clinical trial's dedicated support line.

Our findings show that lower income older adults face compounding barriers to exercise including past injuries and major life disruptions such as losing a job or home, and limited transportation making strong social networks critical for everything from getting to the gym to troubleshooting technology. Prior work confirms that exercise interventions in lower income communities succeed when they foster social connections in a familiar environment and realistically account for participant lifestyles [46].

EngAGE on the VA combined with social support provided greater motivation for some compared to the paper exercise group. Social support should serve as a foundation for technology-based health interventions while the VA technology features (e.g., voice commands and adaptable exercise difficulty) add additional value. Our findings align with Toyama's theory of technology as amplifier [102, 103]: the VA amplified existing motivation and social support rather than substituting for them, and could widen disparities where device access, connectivity, and technical support are unequally distributed.

For lower-income communities specifically, having the user designate a care partner and providing hands-on professional support to build habits and answer technical questions can make or break a preventative health VA intervention. Future work should examine how long an intensive support period needs to be to support habit formation long-term. Alternatively, a VA-based app could be used to supplement (but not replace) in-person workouts at home and allow older adults to connect socially and encourage each other. To offset the financial and technical barriers to adoption, health applications like EngAGE could also be developed for a mobile phone or smart TV, as opposed to a separate device.

6.4 Limitations

Recruitment was extremely challenging, resulting in a smaller, mostly female participant pool. Future work could investigate why women may be more interested in this type of study than men. Baseline VA data was not available since participants were provided VAs as part of the clinical trial. Also, we only interviewed a subset of participants in the clinical trial with trial outcomes pending completion of the trial. In addition, while our qualitative approach focuses on issues encountered by Black older adults, future studies could examine experiences across diverse cultural backgrounds, regions, and socioeconomic statuses.

7 Conclusion

Over four years working with a clinical trial team, we conducted two qualitative studies with Black older adults in a lower income community to examine how they perceive and use VAs for exercise. Study 1 identified five interpersonal relational types—tool, amusement, friend, other, and intruder—that shaped participants' willingness to use a VA for health. Study 2 found that while the VA exercise app motivated some participants, social support and intrinsic motivation were the most critical factors across both VA and paper groups.

Our work contributes to the scarce literature on VA use in healthcare for Black older adults with chronic illness and/or functional limitations through a rare long-term comparative study centering the intersection of race and disability. We suggest that future VA apps for preventative health be designed to be more culturally contextual and capable of fostering rather than replacing existing social relationships, particularly for older adults with multiple chronic health conditions. Our work can inform the design of future VA health applications for minoritized older adults with accessibility issues.

Acknowledgments

We thank Vallary Muhalia for her contributions as a research assistant on this project and all our study participants. This work was funded by NIMHD P50MD017349-01. We also thank the clinical field team including Megan Huisingh-Scheetz, Brittni Bryant, Brandon Foster, and Corliss Taylor. We used Claude (Anthropic) to assist with manuscript editing and literature suggestions; all substantive scholarly decisions were made by the authors and the authors wrote all the text.

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A Supplementary Materials

A.1 Study 1: Moderator Guide for Focus Groups

Initial Interview: Baseline Information

A.1.1 Home and social life.

- How long have you lived in the area?
- Do you have friends and family in the area?
- Who do you see regularly? Who do you live with?
- What does your day-to-day look like?
- How do you usually communicate with your friends and family? How often do you talk with friends and family?
- Where do you usually socialize?

A.1.2 Preventative health.

- How do you generally keep physically active? What kinds of exercise do you do?
- Where do you get ideas and information about what exercise to do from? Is anyone helping you plan this?
- Where do you usually exercise? Do you track the kinds of exercise or activity that you do?
- Is there anything in particular that you'd like to do better in terms of physical activity?
- How do you generally keep mentally active? Are there any technologies you use to help facilitate this?
- How do you decide what to eat during the day?

A.1.3 Medical.

- How do you take care of your health? Does anyone else help you with this, if so who?
- How do you usually communicate with your doctor? To what extent do you feel able to easily reach your doctor when you need them?
- If you have a non-urgent medical question, who do you usually ask? Why?

A.1.4 Technology.

- What type of technology do you use? (i.e., phone, computer, etc.)
- How often do you use technology in your home? How about when you're out in public places?
- When was the last time you got a new device? Can you tell me about it.
- Is there anyone in particular who helps you set up new technology?
- If you have a problem with technology, who do you ask for help? Why?

Interaction Activity With Amazon Alexa and EngAGE

Today we're going to be trying out a technology called a voice assistant. [Explain if needed] *Voice assistants are a kind of smart speaker that you can talk to. Some recent examples are Amazon's Alexa, Apple's Siri, and Google Home. We'd like to ask you a few questions about this kind of technology.*

A.1.5 Voice assistants.

- Do you have any experience interacting with a voice assistant (like Siri or Alexa)? Tell me more.
- If yes:
- What was your favorite thing about your interaction? What was your least favorite?
- To what extent have you found the voice assistant to be useful for you? Follow up if not clear: What has it been useful for?
- Have you ever used a voice assistant in a health or medical situation? If so, can you tell me about it?
- As far as you know, do any of your friends or family use voice assistants?
- Do you have any privacy concerns about voice assistants? If so, what are they?

A.1.6 Task 1: Unbox and plug in. To start out, we'd like you to unbox the device and plug it in. There are two pages in your packet with an introduction to what the Echo device is and how it works that you can review first. We would love to hear any feedback you have on what makes sense, what's confusing, or anything else that stands out to you as you go.

- Are there parts of the guide that were particularly unclear?

A.1.7 Task 2: Connect to Wifi. We'd like you to try connecting the device to wifi. There are a couple of pages in the packet that have information on how to do this [show which pages]. Like last time, let us know if you have any feedback about the document.

- Are there parts of the guide that were particularly unclear?

A.1.8 Task 3: Ask Alexa a question from the Tip Sheet. In your packet, there is a sheet of possible things you can ask Alexa called "Talk to Alexa About Other Things!" Why don't we try a few?

A.1.9 Reviewing the interaction.

- What did you think about the set-up process?
- How did you feel interacting with Alexa?
- To what extent do you think Alexa is like a smartphone?
- How do you think other people in your household would feel about having an Alexa around?
- What do you imagine you might use Alexa for?
- What do you think Alexa should or shouldn't know? Is there anything you wouldn't tell Alexa?
- If you were going to describe Alexa and the Echo Show to a friend who hadn't used it before, how would you describe it?

Sketching activity

Now we're going to do a short drawing activity. [Hand out sheets] *First, could you draw where you would put the Echo Show device in your home? We're not looking for works of art, any kind of sketch or diagram is great.* [Wait] *Next, could you draw what you think Alexa looks like?* [Wait] *Thanks so much. Can you tell me about your drawings?*

Look at EngAGE & "Alexa Together"

- There are a couple of screenshots of the exercise program EngAGE at the end of your packet. Let's take a look at those. Do you think this is something you might be interested in using?

- Amazon has also developed a program called Alexa Together designed for seniors that lets people call for help if they fall, for example, and also lets kids or caregivers monitor the senior's interactions with Alexa. Here is how they describe it [show screenshot]. This is not something we made and we don't have any connection to Amazon, but we are curious to hear, from your perspective, to what extent is this something you'd be interested in using?

Debrief

- To what extent do you think you will use voice assistants going forward? Why or why not?

A.2 Alexa Tip Sheet

Figure 5: Alexa Tip Sheet given to participants to try out various requests with the Amazon Echo Show

A.3 Study 1: Demographic Survey

(1) What is your age?
- 34 years or younger
- 35-44 years old
- 45-54 years old
- 55-64 years old
- 65-69 years old
- 70-74 years old
- 75-79 years old
- 80-84 years old
- 85-89 years old
- 90-94 years old
- 94 years or older
- Prefer not to answer

(2) What is your gender?
- Female identifying
- Male identifying
- Non-binary
- Prefer not to answer
- Prefer to self-describe:_

(3) Which category best describes you?
- American Indian or Alaska Native
- Asian
- Black or African American
- Hispanic, Latino, or Spanish origin
- Native Hawaiian or Pacific Islander
- White
- Prefer not to answer
- Prefer to self describe:_

(4) What is your highest level of education?
- Less than High School Degree
- High School Degree
- Associate's/Some College Degree
- Bachelor's Degree
- Master's Degree
- Doctoral Degree
- Prefer not to answer

(5) What is your estimated annual income? _ or Prefer not to answer

(6) What is your occupation _ or Prefer not to answer

A.4 Study 2: Paper Group Interview Protocol

A.4.1 Physical Activity Experience.

(1) Before you started the program, what types of exercise did you do?
  (a) How often?
  (b) What motivated you to exercise? Were there things that made exercising difficult?

A.4.2 Typical Day & Routine.

(1) What time of day do you usually do the paper exercises?
(2) How long do you usually spend?
(3) How do you remember to do the exercises? What motivates you?

A.4.3 Exercise Experience.

(1) Did you ever feel that the paper exercises were not as good as your previous routine? Why or why not?
(2) Were there any exercises that were unclear or confusing? Why or why not?

A.4.4 Caregiver & Doctor Support.

(1) Can you tell me a little about your care partner in the study?
  (a) What is your relationship to them?
  (b) How did they support you?
  (c) How often did you talk with them about the exercises?
  (d) Do you think your caregiver improved your experience? Why or why not?
(2) Who in your life helps you to stay healthy?
  (a) How do they support you?
  (b) Did you ever reach out to this person about the exercises?

A.4.5 Overall & Future Use.

(1) Do you think the paper exercises have changed how healthy you are? How or why not?
(2) How do you think your experience will change your health and routines in the future, if at all?
(3) Do you have any feedback to improve the study for people in the future?

A.4.6 Alexa.

(1) As part of the study, you were given an Amazon Alexa. Did you ever use it? [If yes] What did you use it for? [If no] Why not?

A.5 Study 2: EngAGE Group Interview Protocol

A.5.1 Physical Activity Experience.

(1) Before you started the program, what types of exercise did you do?
  (a) How often?
  (b) What motivated you to exercise? Were there things that made exercising difficult?

A.5.2 Typical Day & Routine.

(1) What time of day do you usually do the EngAGE exercises?
(2) How long do you usually spend?
(3) How do you remember to do the exercises? What motivates you?

A.5.3 Exercise Experience.

(1) Did you ever feel that the EngAGE exercises were not as good as your previous routine? Why or why not?
(2) Were there any exercises that were unclear or confusing? Why or why not?
(3) Is there anything you wished EngAGE could do that it didn't do?
(4) Did you use either the reminder or tracking system?

A.5.4 Caregiver & Doctor Support.

(1) Can you tell me a little about your care partner in the study?
  (a) What is your relationship to them?
  (b) How did they support you?
  (c) How often did you talk with them about the exercises?
  (d) Do you think your caregiver improved your experience? Why or why not?
(2) Who in your life helps you to stay healthy?
  (a) How do they support you?
  (b) Did you ever reach out to this person about the exercises?

A.5.5 Overall & Future Use.

(1) Do you think the EngAGE exercises have changed how healthy you are? How or why not?
(2) How do you think your experience will change your health and routines in the future, if at all?
(3) Do you have any feedback to improve the study for people in the future?

A.5.6 Alexa.

(1) Had you used a voice assistant like Alexa or Google Home before?
(2) Did you ever interact with Alexa outside of using EngAGE?
  (a) What did you use Alexa for?
  (b) What did you think about the interaction?
(3) Did you ever have a problem with your internet connection?
(4) Is there anything you wouldn't say with Alexa in the room?
(5) Would you want to use Alexa for other health applications in the future? Why?

A.6 Study 2: Participant Self-Reported Chronic Conditions

This data was collected by the clinical team based on self-report from the 20 clinical trial participants in Study 2 prior to the start of the clinical trial.

Chronic Condition	EngAGE Group	Paper Exercise Group	Total
High blood pressure	9	7	16
Back pain	5	4	9
Diabetes	5	3	8
Osteoarthritis	3	5	8
Heart disease	1	4	5
Lung disease	1	4	5
Rheumatoid arthritis	1	3	4
Cerebrovascular accident (Stroke)	1	2	3
Thyroid problems	1	2	3
Covid	2	0	2
Blood disease	0	1	1
Kidney disease	1	0	1
Osteoporosis	0	1	1
Stomach ulcer	0	1	1
Cancer	0	0	0
Liver disease	0	0	0

Table 7: Participants in Study 2 (N=20) reporting "Yes" to a self-reported questionnaire about pre-existing conditions prior to the start of the clinical trial. All other participants responded "No".