Time to listen: a mixed-method study examining community-based views of mobile technology for interventions to promote physical activity

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ABSTRACT

Introduction A mixed-method, co-design approach to studying the adoption of mobile health (mHealth) technology among African-American (AA) women has not been fully explored. Qualitative data may contextualise existing knowledge surrounding perceptions of mHealth among AA women as part of formative work for designing a physical activity application (app).

Methods A convenience sample of 16 AA women completed an informatics survey prior to participating in focus groups exploring their use of mobile technology and health apps. Survey responses provided frequency data, while iterative transcript analysis of focus groups identified themes.

Results The majority of participants (mean age=62.1 years, SD=6.6) felt comfortable using a tablet/smartphone (75.0%). Most (68.8%) reported using health-related apps, primarily focused on physical activity and nutrition. Focus groups revealed four overarching concepts, including (1) user attachment, (2) technology adoption, (3) potential facilitators and (4) potential barriers. Important features which may serve as facilitators or barriers to future adoption of a mobile app for an mHealth intervention include individual app tailoring and software concerns, respectively.

Discussion Thematic analysis revealed high user attachment to smartphones and described participants' process for adopting new mHealth technology.

Conclusion Early engagement of target end users as a part of a broader co-design and community-based participatory research process for developing mHealth technologies may be useful for sustained adoption of these tools in future mHealth behavioural interventions.

Summary

What is already known?

► Mobile technologies are widely accepted in the general population.
► Mobile health (mHealth) technologies may have the potential to facilitate low-cost, far-reaching interventions in chronic disease management, physical activity (PA) and obesity. However, evidence of their feasibility has been mixed.
► A recent review of mHealth-based interventions revealed limited data on use of co-design in developing PA promoting tools, especially among African-Americans.

What does this paper add?

► The current study complements survey data with qualitative data collection approaches to understand how urban African-American women use and perceive both mobile technology and mHealth tools.
► The participants self-reported competency and comfort with using mobile technology and voiced their preferences for how future PA apps should be designed with specific requests regarding mHealth app features. The participants emphasised the need for cultural and community-level customisation of mobile apps and the importance of partnership and collaboration between the research team and community.
► Our participant-oriented methodology represents an important first step in co-design and facilitates our ability to improve the next iteration of the app for future testing.

INTRODUCTION

There is a growing interest in capitalising on the use of mobile technology to improve health outcomes, such as obesity, diabetes and hypertension.[1,2] These cardiovascular risk factors disproportionally impact racial/ethnic minority groups and low-income populations in the USA; these groups are also less likely to achieve recommended levels of physical activity (PA), which is an important factor for mitigating the development of cardiovascular disease.[3,4] Mobile health (mHealth) technology such as wearable devices, smartphone applications (apps) and Bluetooth-enabled diagnostic tools permeate consumer markets,[1,5] including urban African-American

communities in the USA,[6] and are commonly used to help individuals self-monitor health behaviours such as PA. mHealth interventions may be used to disseminate health information and induce positive behavioural change in an affordable and efficient manner, especially for vulnerable populations at highest risk of cardiovascular disease. mHealth technology has been proposed as a method for alleviating inequities among populations experiencing health disparities or limited access to traditional healthcare, such as lower income and racial/ethnic minority communities.[7 8] However, current literature evaluating the effectiveness of mHealth interventions demonstrates mixed results.[9] This may be due, in part, to intervention designs based on researcher assumptions of mHealth user needs and preferences which are not valid in diverse study populations.[10–12] Thus, a culturally tailored approach may be needed to achieve desired outcomes among specific minority populations, such as African-American women. The community-based participatory research (CBPR) framework involves partnerships with target populations early in the development and design phase, while codesign incorporates end-user preferences and opinions. Co-design is a process where technology end users, relevant stakeholders and researchers partner on all aspects of mHealth intervention development, from needs assessment to content development, pilot testing and dissemination.[13] This process is similar to CBPR, which has demonstrated success in minority communities historically left out of health behaviour interventions, and provides a foundation for tailoring an mHealth intervention.[14–17]

The co-design process and CBPR framework share core principles including: mutual collaboration between communities and researchers, capitalisation on community strengths and a focus on sustainability. While CBPR emphasises the co-learning between communities in partnership, co-design is a process wherein stakeholders (participants) are involved in rapid, iterative testing of ideas to develop mHealth interventions. Current mHealth literature on app development, especially in the context of co-design, lacks involvement of the intended user in early stages of development.[18–21] Together, both co-design and CBPR result in an assessment and accommodation of users' preferences that may ultimately improve intervention effectiveness in diverse populations.[22] Therefore, a co-design approach may be needed to develop mHealth interventions according to baseline technology use and user perceptions, allowing for more adequate assessment of the impact of mHealth technologies and improved intervention outcomes.

There is a need for co-design with end user and community involvement in the early development stages to properly evaluate end user background knowledge, perceptions of mHealth tools and needs.[11 23–25] This is even more important for minorities and health disparity populations such as African-Americans.[26 27] Limited studies have explored African-American users' perceived benefits and barriers to mHealth and, when available, rely solely on survey data.[28–31] Furthermore, a recent review of mHealth-based interventions which employed co-design methodologies and collected qualitative data assessing African-American perceptions of mHealth interventions revealed limited data on use of co-design in developing PA promoting tools.[23 32–39]

The purpose of this study is to understand the views of urban African-American women regarding mHealth technology as a first step of an iterative process to develop a culturally tailored PA app. Using a co-design approach in the development of an mHealth tool, we aim to augment the traditional survey approach with in-depth focus group analysis for a more comprehensive understanding of the facilitators and barriers for using mHealth technology facing this community.

METHODS

Overall study design

The data reported here are part of formative research to develop a PA intervention targeting African-American women at risk for cardiovascular disease.[40] The decision to develop a culturally tailored PA-promoting app arose from the community-based Washington, D.C. Cardiovascular Health and Needs Assessment.[6 41] Results presented in this paper represent the participants' thoughts *prior to* engaging in the pilot PA intervention and using the study app.

Study recruitment and sample

CBPR methods rooted in the Communication, Awareness, Relationships and Empowerment recruitment model[14] were employed to establish rapport with residents in the Washington, D.C. metropolitan area. Community engagement was accomplished through a community advisory board (CAB), the D.C. Cardiovascular Health and Obesity Collaborative, which provides input on study design and execution of community-based protocols at quarterly meetings. Founded in 2012, the CAB is composed of church and community leaders from academia, community health advocacy groups, healthcare organisations and non-profit organisations who are invested in improving cardiometabolic health outcomes in the community. Partner organisations also spread awareness of the study, invited study team members to speak to congregations and provided contact information for interested participants. We recruited African-American women ages 19–85 with overweight/obesity who reside in Washington, D.C. Wards 5, 7 and 8 or Prince George's County, Maryland, as these regions have disproportionately high rates of obesity and cardiovascular disease. All participants provided written informed consent.

Onsite procedures

Participants first completed a 24-item technology use survey (see online supplementary table 1 online supplementary table 1). The questionnaire was adapted from a survey instrument for African-American populations,

as well as the Health Information National Trends Survey.[30 31 42]

Participants took part in one of two simultaneous, semi-structured focus groups about their use of mobile technology and mHealth technology. Participants were asked to advise the research team about conducting mHealth research in their communities, as well as indicate their willingness to participate in future mHealth research. The focus groups (n=8 each) were conducted separately to allow all participants greater opportunity to speak and lasted approximately 1.5 hours. Each focus group was led by two study team members, a moderator and a facilitator, with additional note takers present to document nonverbal responses. A Moderator's Guide included preselected questions and probes but allowed for open discussion based on the comments raised (see online supplementary table 2). The focus groups were audio recorded and transcribed verbatim by an independent clinical research organisation (Social Solutions International, Silver Spring, Maryland, USA).

Data analysis

For the quantitative analysis, descriptive statistics of responses to the technology use survey were calculated using SAS V.9.4 (SAS Institute). For the qualitative analysis, the research team first validated the focus group transcripts against the audio recordings by simultaneously listening to the recordings while reading the prepared transcripts. Then, three independent coders systematically developed a codebook of themes and their conceptual definitions. The rest of the research team contributed to further iterations of coding. Six versions of the codebook were considered until consensus was achieved. A National Institutes of Health qualitative research expert (GRW) validated the final coding and corresponding themes. Although use of NVivo software was considered, the research team elected to use a consensus-based approach that was achieved through multiple readings, discussions and coding sessions as this method is widely used by qualitative researchers in the literature.[40 43–46]

RESULTS

The study sample had a mean age of 62.1 (SD 6.6) years and a mean body mass index of 35.5 kg/m^2 (range: 25.6–54.6 kg/m^2; table 1). The majority of participants were retired or unemployed (62.5%) and had at least a college level education (75.0%). Income information was only available for eight participants, with the majority (62.5%) having a household income at or above US$60 000.

Survey data: technology use behaviours

Most participants reported feeling comfortable using both a computer (81.3%) and a tablet/smartphone (75.0%), and having reliable access to the Internet from a variety of locations (home, library, work, etc; table 2). Two-thirds had Android devices (68.8%) and nearly half were enrolled in unlimited data, talk and text plans

Table 1	Sample characteristics mean (SD)
Age (years)	62.1 (6.6)
Female	16 (100.0)
African-American	16 (100.0)
Employment status	
Employed	6 (37.5)
Retired/unemployed	10 (62.5)
Income	
< US$60 000	3 (37.5)
≥ US$60 000	5 (62.5)
Education	
Some college, or below	4 (25.0)
Technical degree	2 (13.3)
College degree	7 (43.8)
Graduate/professional degree	3 (20.0)
Marital status	
Single/divorced/widowed	12 (75.0)
Married	4 (25.0)
Location of residence	
Maryland	7 (43.8)
Washington, D.C.	9 (56.3)
Weight parameters	
BMI (kg/m^2)	35.5 (8.3)
Overweight (BMI ≥25 kg/m^2)	4 (25.0)
Obese (BMI ≥30 kg/m^2)	12 (75.0)

BMI, body mass index.

(43.8%). However, 67% did not know their monthly data limit. Texting/messaging (93.8%) or calling (87.5%) family and friends, followed by sending/receiving email (68.8%) were the most commonly used smartphone functions. All participants reported having apps on their smartphone. Approximately 70% reported using health-related apps. Those who used health apps indicated that the most common reasons for use were to increase PA (56.3%) and track diet or nutrition (43.8%). Almost half of mHealth app users (45.5%) reported using these apps daily. Finally, participants reported a willingness to engage in future mHealth research (table 3), especially interventions with dissemination of health information via email (93.8%) or text (75.0%) and with components that involve interacting with peers online (62.5%) or using wearable devices (62.5%). Motivation to participate was centred around personal interest (81.3%) and augmenting personal knowledge of a topic (81.3%). When presented with known barriers to participation in research with mobile technology (such as mistrust, privacy, access), most participants (37.5%) chose none of the above. Finally, if participating in an intervention, the mean number of desired daily messages was 4.2 (SD 5.6), with a mean upper limit of 9.2 (SD 13.3).

Table 2 Survey items and summary responses of technology use behaviours (N=16)

	N (%)
Where do you go to access the internet?*	
Home	13 (81.3)
Any location (ie, smartphone or tablet)	12 (75.0)
Home of family or friend	4 (25.0)
Work	4 (25.0)
Public spaces (ie, library, community centre, restaurant, café)	5 (31.3)
Please indicate if you have any of the following devices:*	
Smartphone, such as iPhone, Android, Blackberry or Windows	16 (100.0)
Desktop computer or laptop	13 (81.3)
Tablet computer, like an iPad, Samsung Galaxy Note or Kindle Fire	12 (75.0)
What type of smartphone do you have?	
Android	11 (68.8)
iPhone	4 (25.0)
Other	1 (6.3)
Do you have a data plan with your smartphone or tablet?	
Yes, I am enrolled in an unlimited data, talk and text plan	7 (43.8)
Yes, I am enrolled in an unlimited data, talk and text prepaid plan	3 (18.8)
Yes, I am enrolled in a basic prepaid plan	2 (12.5)
Other	4 (25.0)
How do you use your smartphone?*	
Texting/messaging family or friends	15 (93.8)
Calling friends or family	14 (87.5)
Email	11 (68.8)
Surfing the Internet	7 (43.8)
Health and medical information	6 (37.5)
Business/work	5 (31.3)
Social networks and apps (Facebook, Twitter, Instagram, Tinder, etc)	4 (25.0)
Entertainment (movies, videos, games, etc)	3 (18.8)
Reading books or magazines	1 (6.3)
On average, how much time do you spend on your smartphone daily?	
4–6 hours	2 (12.5)
2–4 hours	9 (56.3)
<2 hours	5 (31.3)
How often do you use apps on your smartphone?	
Every day	9 (60.0)
1–2 times per week	2 (13.3)
3–5 times per week	3 (20.0)
	Continued

Table 2 Continued

	N (%)
Never	1 (6.7)
How often do you use health-related apps on your smartphone?	
Every day	5 (45.5)
1–2 times per week	4 (36.4)
3–5 times per week	1 (9.1)
Never	1 (9.1)
What time(s) during the day are you most likely to check text messages?*	
Early morning	11 (68.8)
Late evening	10 (62.5)
Early evening	9 (56.3)
Late afternoon	8 (50.0)
Early afternoon	6 (37.5)
Late morning	4 (25.0)

*For 'Select All that Apply' questions, total may exceed 16 as answer choices are not mutually exclusive.

Qualitative data: focus group concepts, themes and subthemes

Each focus group had an average duration of 77 min (SD 13). The iterative transcript analysis resulted in 4 overarching concepts, with 12 themes and 9 subthemes divided across the concepts: user attachment, technology adoption, potential facilitators and potential barriers (table 4). Overall, participants reported comfort with using mobile technology and voiced their preferences for future mHealth app features. They repeatedly emphasised the need for community-level customisation of the app as a preferred feature of future apps. In addition, participants noted the advantages of integrating multiple health behaviours into one mobile app. Illustrative quotes are included in online supplementary table 3.

User attachment and technology adoption

Participants reported being attached to their phones at all times and locations (eg, places of worship, grocery stores, etc) since they found their devices to be helpful in many settings, stating that they are on their phones 'all day, every day' and 'anywhere, for real, for real'. Aside from traditional functions of a phone (texting, calling), participants listed a range of functions that they regularly use (eg, taking pictures, searching the web, banking, calling ride-share cars). Convenience was repeatedly emphasised not only from the perspective of access to information and resources, but also efficiency and cost effectiveness. One participant noted that she 'save[s] a lot of gas money' by using her phone to accomplish errands that she previously had to complete in person. Although participants described different ways by which they integrate mobile technology in their daily lives, those with underdeveloped skills demonstrated a readiness and

Table 3 Participation in mobile health (mHealth) research (N=16)

	N (%)
Would you be willing to participate in a research study that tested and/or had the following components?*	
Intervention components	
Health education sent to your personal email	15 (93.8)
Health education text messages	12 (75.0)
Interacting with peers or a community group online	10 (62.5)
Interacting with peers or a community group in-person	8 (50.0)
Health education notifications	6 (37.5)
Comparing health data (ie, average steps per day, health goals) between friends or family	7 (43.8)
Comparing health data (ie, average steps per day, health goals) between strangers	6 (37.5)
Intervention platforms	
Smart watches or wristband monitors	10 (62.5)
Online support or counselling with a health professional	10 (62.5)
Websites to log data	8 (50.0)
Smartphone/tablet apps	7 (43.8)
What would motivate you to participate in a research study using mobile technology (ie, smartphone, tablet, etc)?*	
Interest in topic	13 (81.3)
To become more educated about a topic	13 (81.3)
Positive impact on life	10 (62.5)
Research helping minority groups	9 (56.3)
Contribute to the greater good	8 (50.0)
Encouraged by friends or family	7 (43.8)
Presence of ethnic/racial minority or female on the research team	6 (37.5)
Managing disease/condition/illness	6 (37.5)
Financial incentive	5 (31.3)
To gain technical or computer skills	4 (25.0)
Referral from a doctor/health professional	4 (25.0)
Diagnosis with disease/condition/illness	4 (25.0)
Free medication check-up	3 (19.8)

Continued

Table 3 Continued

	N (%)
Free cell phone and/or data plan	2 (12.5)
What would keep you from participating in a research study using mobile technology (ie, smartphone, tablet, etc)?*	
No interest in research	4 (25.0)
No interest in topic	4 (25.0)
Concerns about privacy	4 (25.0)
Too busy	3 (18.8)
Mistrust of researchers	3 (18.8)
Research has no value	2 (12.5)
Does not target ethnic/racial minorities or women	2 (12.5)
No ethnic/racial minorities or women on the research team	2 (12.5)
No financial incentives	1 (6.3)
No computer or smartphone	1 (6.3)
No reliable internet access	1 (6.3)
Concerns about data plan	0
None of the above	6 (37.5)

For 'Select All that Apply' questions, total may exceed 16 as answer choices are not mutually exclusive.

eagerness to learn. One participant stated, "I can do some things, but I'd like to learn and do more", while another stated, "I ask questions a lot, until I get it going. Until I get it". Many participants rely on younger individuals, such as children and grandchildren, for assistance with learning new skills and troubleshooting.

Potential facilitators of mHealth adoption
The most preferred features of existing PA apps included monitoring of multiple health behaviours and motivational messages. Desired features for future health apps included connection to existing community resources and personalised content (for motivational messages and goal setting). Participants expected content to be concordant in terms of race/ethnicity, body size, physical capacity and community-level tailoring of content and resources. One participant emphasised, "We don't want like a global, we want personal [messages]", while another emphasised the app should "have what's available in Ward 7" (ie, walking trails, recreation centres, classes, etc). Participants advised the research team to "educate [community members] on a level that they can understand" and "be sensitive to the community that you're dealing with and not prejudge".

Potential barriers to mHealth adoption
Participants did not identify any insurmountable barriers to using mHealth technology. The most disliked mobile phone attributes were related to hardware (small screen size, short battery life), software (passwords, required updates) and data security (hacking) issues. Specific to

Table 4 Focus group concepts, themes and subthemes

Concept 1 User attachment	1. Time
	2. Space
	3. Utility
	Communication
	Convenience
	Information seeking and storage
Concept 2 Technology adoption	1. Readiness to change
	2. Reliance on younger generations
Concept 3 Potential facilitators	1. Health monitoring
	2. Integration of other health information and behaviours
	3. Motivation
	4. Individual and community tailoring
Concept 4 Potential barriers	1. Software concerns
	Passwords
	Advertisements
	Manual logging and data entry
	Software updates
	2. Hardware concerns
	Limited plan or storage space
	Screen size
	3. Uncertainty about hacking

PA and mHealth apps, participants reported disliking manual data entry, with one participant expressing that "it's a challenge because I'm just really not sure how to track the amount or the calorie count or whatever". Although participants voiced concerns about hacking of personal information, it was not a barrier to using mobile phones for health. One participant reasoned, "[my personal information] is out there for somebody to get if they really want to get it. So I don't think I'm really nervous, I'm not going to be paranoid about that, you know?" Furthermore, a participant highlighted the benefits of data tracking when reasoning it could be useful if she went missing, "I have mixed feelings about being able to be tracked or located on my phone. But, I think there may be times when, I'm hoping there's not, but a time somebody would need to find me if we go to that route, but even when I'm just walking it's really interesting".

DISCUSSION

This is a community-based study of African-American women's perceptions of mHealth technologies that marks the first of a co-design process of a culturally tailored PA app. Using a CBPR approach, we provide insight into skills and motivation necessary for using mHealth interventions among African-American women and their reasons, preferences and challenges in adopting mHealth tools.

The Pew Research Center has published data suggesting that the digital divide has persisted even as lower income American make gains in technology adoption.[47] However, when African-Americans do use smartphones, they are more likely than their white counterparts to rely on their smartphones as a resource for health information.[48] This suggests a potential role for smartphone technology in African-Americans' health maintenance moving forward. Few reports have specifically examined technology adoption and use patterns among urban African-American women.[28 30]

Our quantitative survey findings emphasise the breadth and frequency of mobile phone use among this sample of African-American women. Prior published work on the penetrance of mHealth technology have been conducted in different communities and at a time when mobile technologies were less prevalent than today. These results are relevant, but not directly comparable to our own findings. For example, Carroll *et al* found that, in a national sample of US adults, those using health apps also had the intention of modifying a variety of health behaviours: increasing PA (83%), improving fruit (63%) and vegetable (75%) consumption, and weight loss (83%). However, it is unclear if the apps themselves were used to accomplish those goals.[49] In a low-income population of Southern California primary care clinic patients (only 8% African-American), Ramirez *et al* found that 57% use smartphone apps (vs 94% in our study), 32% use health apps (vs 69% in our study) and 86% were interested in using an app to improve their health.[50] James *et al* showed that African-American women use mHealth tools for a variety of reasons, including nutrition/dieting, general health/wellness, medication management and chronic disease management.[28] Similarly, our participants reported dependency on their smartphones and apps in many settings.

The qualitative component of our study enriched the survey by engaging the users in discussions of what many researchers assume are barriers to mHealth interventions, such as the privacy implications of app-based location-tracking during bouts of PA. Issues surrounding privacy and location-based tracking were not substantial concerns to our participants, although they were acknowledged. The participants acknowledged potential data breaches as possible barriers to mHealth use among community members in general, but not themselves. Conversely, previous data have demonstrated that African-Americans are significantly less comfortable with global positioning systems compared with other racial/ethnic groups.[51] This could be attributed to historical abuses of African-American communities by the medical system, including the well-documented examples of unethical research studies which serve as barriers to minority participation in contemporary research.[51 52] However, prior literature suggest that participants' trust in research teams may overcome perceived risks associated with use of mHealth tools in minority communities.[53] The participants in our study may be less concerned with potential privacy

breaches in this study due to the trust afforded by our long-term community presence and current methodological approaches (CBPR and co-design).

Our findings underline the feasibility and importance of engaging end users around mHealth perceptions as a first step in codesign process. Our study adds to prior PA mHealth efforts by specifically obtaining qualitative data from African-American communities to inform a PA mHealth intervention.[23] Co-design has been sparsely employed in mHealth research because it is considered expensive and slow.[10 24] However, involving end users initially can be more time efficient and cost effective by reducing long-term problems, as it may bypass inefficient efforts based on faulty, research-driven assumptions. This approach allows the target population's concerns surrounding mHealth to be addressed prior to technology-enabled intervention implementation and may facilitate higher end-user engagement. Our CBPR methodology facilitates our ability to improve the next iteration of the PA-promoting app and our laboratory has subsequently incorporated the feedback to enhance the development of the PA-promoting app, which continues to be iteratively tested by study participants.

Limitations

The study population was a small, convenience sample of middle-aged, African-American women who were recruited from faith-based communities within the Washington, D.C. metropolitan area. Our sample was skewed towards older and educated women. As a purposive sample, some of our participants personally knew each other, which might have impacted the dynamics of the focus group discussions.

CONCLUSIONS

Qualitative input provided insight into facilitators and barriers researchers should consider when designing an app for this population, such as cultural tailoring and software concerns, respectively. Early engagement of target end users as a part of a broader co-design and CBPR process for developing mHealth technologies may be useful for sustained adoption of these tools in future mHealth behavioural interventions.

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