Original Article

Development of a mobile phone app to maintain physical activity in African American men: *MobileMen*

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Background: African American men experience health disparities across a number of chronic diseases. mHealth technology is widely utilized to address lifestyle factors that contribute to these conditions. Participation of African American men in qualitative and quantitative studies of mHealth is low. Therefore, little is known regarding the acceptability of mHealth interventions and few interventions have been specifically developed for this population. The purpose of the current study is to describe the development of a smartphone application, *MobileMen*, to promote the maintenance of physical activity (PA) in African American men and to report on app feasibility when applied to the target population.

Methods: We used a mixed methods study design including formative research, user-centered design, and a feasibility study. Focus groups (n=26) were conducted to inform the acceptability of the app and desired features. Lab usability (n=19) was used to develop the app through an iterative process. A feasibility study was conducted to assess utilization of the app over a 1-month timeframe. Measures of usability and user-friendliness were collected during lab usability sessions. Satisfaction and app usage were collected following the feasibility study.

Results: The focus groups revealed that African American men use smartphone apps and that they are willing to utilize an app to maintain PA habits. The *MobileMen* app was subsequently developed and contained a dashboard, rewards, a learning component, a prompting system, and activity tracking. Scores increased between the first and last lab sessions for usability [5.0 (0.0) *vs.* 4.3 (1.0)] and user-friendliness [74.2 (17.0) *vs.* 70.6 (12.4)]. Participants reported acceptable satisfaction (mean values >3.5 on a 1–5 Likert scale) with most app components.

Conclusions: African American men are willing to utilize mHealth to improve their health behavior, including PA. An initial version of the *MobileMen* app has been developed that is acceptable and user-friendly. However, there are several components requested by African American men could not be included in the current app but warrant future app development.

Keywords: African American, male, smartphone, exercise

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Introduction

Relative to White men, African American men have a higher rate of morbidity and mortality from chronic disease, including obesity, cardiovascular disease, hypertension, stroke, diabetes, and prostate cancer (1-3). One of the major modifiable risk factors for these diseases is physical activity (PA). Increased levels of PA and fitness have been associated with reduced risk of developing obesity, cardiovascular disease, diabetes, and other chronic diseases in African Americans (4,5). African American men's amount of PA falls below national guidelines (6-8), as data show that between 48.4% and 58.4% of African American men self-report not meeting the standard. To date, there are a limited number of PA interventions specifically targeting African American men (9,10). Therefore, there is a need for more interventions that are effective in increasing and sustaining PA to reduce African American men's risk of developing chronic disease.

Mobile health (i.e., mHealth) is an emerging form of intervention delivery because it is portable, allows for real-time feedback from participants, allows for a larger dose of an intervention to be delivered, and has the potential for wide spread delivery. It is especially appealing when targeting African Americans because recent estimates show that 94% of African American adults own a mobile phone (11), 72% own a smartphone (11), and nearly 70% utilize mobile phones to access health information (12). African Americans view mHealth interventions favorably (13-17), and mHealth interventions have been shown to be effective when delivered to African American populations (14,15,18-21).

Although it has been shown that African American adults utilize mobile apps to obtain health information, African American male participation in mHealth studies is low (13-15,17,19,22). The data on African Americans' use of mHealth technology are based on information primarily derived from African American women. For example, studies assessing the acceptability of mHealth interventions in African Americans have been based on samples that were ≥80% female (13-17). As a result, there is limited information on views of mHealth technology by African American men and subsequently, there are limited numbers of mHealth interventions developed specifically for this population. It has been shown that utilizing a targeted intervention strategy increases the attention to and effortful processing of information, as well as the potential impact of an intervention (23-25). This is important because it suggests that chronic disease prevention interventions targeting African American men are not utilizing the most recent advances in behavior change science nor are they having the greatest potential impact on this underserved population. These factors suggest that there is a need for information specifically derived from African American men in order to tailor programs to their specific needs.

Current apps targeting African American men have mainly been utilized in prostate cancer awareness and screening (26,27) or HIV testing and prevention (28-31). To our knowledge, no apps exist that target PA or related chronic diseases. Therefore, the purpose of the current study, *MobileMen*, is to describe the development of a smartphone application targeting maintenance of PA in African American men. The study included heavy formative work involving African American men and iterative app development. Finally, we reported on the feasibility of using the app with the target population.

Methods

Study design

We used a sequential mixed methods study design (32) including formative research, user-centered design, and a feasibility study. Formative research is designed to understand the personal, cognitive, economic, and sociocultural factors that influence health behavior in order to develop meaningful and effective interventions (33) and took the form of focus groups (*Supplement 1*). Focus groups for the current study served to ascertain African American men's beliefs about PA, utilization of mHealth, and app features necessary to promote sustained PA. User centered design (34) solicits user input through iterative cycles and adjustments are made based on feedback, resulting in greater user experiences, and more reliable and effective results (35,36) and was fostered through multiple rounds of usability testing. This iterative user-centered design was utilized to develop the actual smartphone application. Finally, a feasibility study was conducted to assess usability and satisfaction with the *MobileMen* app. All procedures were approved by the Pennington Biomedical Research Center Institutional Review Board.

Theory

The theoretical underpinnings of the study are largely based on the Social Cognitive Theory (37). Maintenance strategies commonly found in behavioral studies were also

incorporated, based on problem-solving (38) and relapse prevention (39). The study also recognized the importance of culture and therefore information was gathered from, and the app was tailored (40) to, an African American male population. Finally, we identified factors that have lead to success in mobile phone interventions (41). Outcome data from the focus groups and usability testing outcomes were also utilized in the development of the app.

Participants

In order to be eligible for the formative and user-centered design phases of the study, participants had to (I) self-identify as an African American male, (II) be 18 years of age or older, and (III) speak and read English. Exclusion criteria included (I) cognitive impairment that would interfere with participating in a group discussion, (II) audio and video tape refusal, or (III) written informed consent refusal. The mean age for participants in the focus groups and usability testing was 48.6±12.5 years and 41.6±16.3 years, respectively. In order to be eligible for the feasibility study, participants had to (I) self-identify as an African American male, (II) be 18 years of age or older, (III) speak and read English, (IV) own an Android or Apple based smartphone, and (V) self-report regular exercise (answer "Yes" to the question "Do you currently exercise at least 30 minutes 3 or more times a week?"). Exclusion criteria included unwillingness to wear a Fitbit. The mean age for participants in the feasibility study was 35.4±17.7 years of age. No other demographic information was collected because this data was unlikely to have a large impact on the outcomes and the men's beliefs about a smartphone app for maintaining PA.

Recruitment strategies included community events (presentations at churches, health fairs, etc.), listservs, flyers at community locations, and social media (i.e., Facebook). Participants were compensated $25 for participation in each focus group, $25 for usability testing, and $50 for the feasibility study.

Focus groups

Focus groups were conducted from November 2016 through March 2017. All focus groups took place in the evening and were conducted at a local YMCA or library. All participants signed informed consent before each focus group began. Each focus group was comprised of African American men recruited from the Baton Rouge area and were approximately 1 hour in duration. Two rounds of two focus groups (i.e., a total of 4 focus groups) informed prototype development. The focus groups were designed to gather information that would inform the development of a PA maintenance app rather than seeking themes that cut across focus groups.

The first set of focus groups was designed to determine the feasibility of developing a PA maintenance app and essential features of such an app. The men were guided in discussing eleven questions that explored the following topics: (I) thoughts about exercise, (II) personal importance of being physically active, (III) barriers to exercising regularly, (IV) barriers to maintaining a PA program, (V) personal facilitators of maintaining a regular exercise regimen, (VI) use of mobile phone apps, (VII) experiences using smartphone apps, (VIII) perceived utility of an app to assist in maintaining a PA routine, (IX) essential app features to assist in maintaining a PA program, (X) essential app features to foster continued use, and (XI) aspects of personal demographics needed to specifically tailor the app. The first focus group was led by authors DG, RLNJr, and LC and the second by RLNJr and LC. The groups consisted of smartphone users and non-users, and active and inactive men. The first focus group was recorded, notes were taken (LC), and the event was transcribed. The transcripts were reviewed by RLNJr, LC, and JStR and the importance of an issue was determined by how frequently it was raised across focus groups and questions. The results of the focus group were discussed between the teams at Pennington Biomedical (RLNJr, LC) and Klein Buendel (VHM, TJ). The men's input was used to determine which features would be included in the app and subsequent development of included features began.

The second set of focus groups was designed to evaluate proposed app features, provide input on app design, content, and overall engagement. Wireframes of the app prototype were shown to the participants. These wireframes included images of proposed features and content including the notification system, depictions of African American men, the incentives, etc. These focus groups were led by RLNJr and LC. The group consisted of smartphone users and non-users, active and inactive men; men from the first focus groups were invited to participate. The same process of documenting participant input and discussion between the teams occurred in the second set of focus groups as was done in the first. Information gathered during the two sets of focus groups allowed the investigators to make decisions regarding essential features to include and exclude. A functional prototype was created following the focus groups.

Usability testing

Usability testing was conducted on the Pennington Biomedical campus. Sessions were conducted at the convenience of the participants and lasted approximately one hour. Usability testing was conducted in an individual format and consisted of (I) allowing participants to freely navigate the app prototype and (II) conducting a structured interview that guided participants to all parts of the app prototype. The lab usability sessions were conducted by Pennington Biomedical staff (LC, JStR) (*Supplement 2*). Participants were encouraged to verbally express their thoughts as they interacted with the app during the free navigation component (e.g., think aloud method) (42). Specifically, participants were asked to describe features they were looking for, which ones were useful, whether anything was useless, and what might be missing. Following the free navigation, participants were directed towards all parts of the app through direct questions, including "Imagine you have been using the *MobileMen* app for a week or two. You are opening the app to view your exercise progress. Where would you go to find this information?", "Show us where you would go to manually enter an exercise bout.", "Show me where you would go to find the badges you earned within the app", and "Imagine you are interested in learning more about ways to maintain your exercise habits. Where would you go to find that information?". Follow up questions assessed the ease of finding the specific feature, perceived usefulness, potential additions, and potential alterations. To summarize the participants experience, they were asked a series of questions consisting of (I) what features would they change and how, (II) what features would they keep, (III) what would encourage them to use the app, (IV) what was most liked, (V) what was least liked, (VI) what would they change, and (VII) how would the app be helpful. These sessions were recorded and the interviewers took notes during the testing.

Several rounds of usability testing were planned based on the iterative app design approach. In the first round, basic app functionality was tested with subsequent recommendations for immediate improvements to the design. In the second round, enhanced functionality was tested to identify and correct usability problems before the app was complete. In the third and fourth rounds, fixes were validated and any remaining problems were identified and subsequently corrected. We targeted eight participants in each round, and all participants were new to the study. The lab usability allowed the investigators to decide which features would be included and excluded, how each feature would manifest in the app, how the app would function, and how the app would appear to the user. The fully functional app was created following usability testing and was utilized in the pilot study.

Feasibility study

A feasibility study (i.e., beta test) of the fully programmed app was conducted in the Baton Rouge area with 10 African American men who used the app for 1 month. Research in the area of user experience design suggests that between 5 and 10 usability testers are needed to identify the majority of usability issues (43,44). Participants received a one-on-one orientation that included downloading the app onto their personal smartphone and an app tutorial. The men were given a Fitbit® Charge 2 to wear daily, but did not receive access to the Fitbit app. Participants were instructed to utilize the *MobileMen* app over the course of the following 4 weeks to assist them in maintaining PA habits. There was no communication with participants during the four weeks unless the app was not functioning properly. Participants returned to the Pennington Center after one month and completed an individual exit interview that ascertained information on the acceptability and feasibility of the app.

Measures

System usability scale (SUS) (45)

The SUS is a measure of usability for a given technology and is considered the industry standard for measuring usability. The measure was adapted to assess the usability of the app as opposed to the usability of a system in the original version. Scores range from 0–100 and a score of 68 is considered "above average". The men completed the SUS at the end of the lab usability testing.

User friendliness

User friendliness was assessed with one question "Overall, I would rate the user-friendliness of this app as". The scale was scored along a 7-point Likert scale from "Worst imaginable" to "Best imaginable". The men answered the user friendliness question at the end of the lab usability testing.

Satisfaction survey

The survey assessed satisfaction, helpfulness, enjoyment, and cultural relevance of the app. Items are scored on a 1

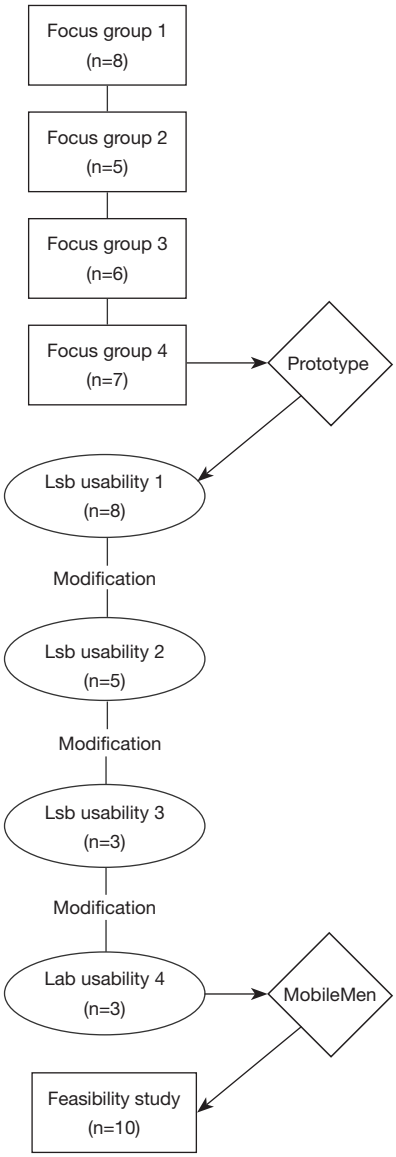

Figure 1 Flowchart of *MobileMen* app development.

(Extremely Dissatisfied/Not at all helpful) to 5 (Extremely enjoyable/Very relevant) Likert-scale. The survey was adapted from a satisfaction survey used in another study by the lead author (46), and assessed the dashboard, rewards, a learning component, a prompting system, and activity tracking. The survey was administered after participants completed the feasibility study.

App usage

Data was collected on each component of the app.

Data analysis

Transcripts from the focus groups and lab usability were generated. The focus groups were not designed to detect themes, but were instead used to gather information, so no formal qualitative analyses were performed. Response frequencies were calculated for the various app components and step count data. Changes in step counts in the feasibility study were assessed via t-tests. Correlations between step counts and app usage were conducted.

Results

Focus groups

The flow of participants through the app development process can be seen in *Figure 1*. The men in the first set of focus groups (n=5, n=8) indicated that they use smartphone apps and that they would be willing to utilize an app to maintain PA habits. With regards to features, the men most frequently noted that the app needed to have a dietary component (e.g., meal plans, nutrition information, etc.). They specifically wanted dietary plans tailored to either PA routines (e.g., aerobic, strength) or health conditions (e.g., men with diabetes, hypertension, elevated cholesterol). The men also frequently noted that they wanted to be able to track their behavior (PA, weight loss, etc.), the app would have to be personalized (e.g., allow input of health parameters and provide recommendations based on these parameters), and allow them to communicate with other active men and their primary care physician. It was noted that the app would need images of African American men, exercise plans for specific health conditions that African American men experience (i.e., hypertension and diabetes), daily tracking, rewards, to be accessible on devices other than a smartphone (e.g., tablet, smart TV), and to allow for competition between users in order to be specifically designed for African American men.

Two more focus groups (n=6, n=7) were conducted that primarily focused on identifying, reacting to, and refining potential app features. Two men who participated in one of the first two previous focus groups also participated in one of the second set of focus groups. The men were shown wireframes of the feedback, self-monitoring, goal setting, notifications, and reinforcement components, as well as images of African American men engaged in PA to assess their appropriateness for the app. The app was based on behavior theory and therefore, strategies for the

maintenance of behavior change (38,39) were provided in brief articles. These articles were culturally tailored (40) and included surface (e.g., depictions of African American men) and deep (e.g., utilizing examples from African American history) level structure. An example article on problem-solving was read by all participants. The men generally agreed that each component of the app was useful and that they would utilize each component. The reinforcement (i.e., badges) in particular resulted in a great deal of discussion in the first group and resulted in several iterations of badge development between and after the groups.

Prototype

The app prototype consisted of a profile page which allowed participants to enter their name, email, passcode, password, age, weight, height, blood pressure, glucose, and cholesterol. The home screen displayed the *MobileMen* logo and the four available features, the dashboard, activity, badges, and articles. The dashboard contained the last week and month of Fitbit steps in graphical form. The activity section allowed users to self-report activities. The badges feature displayed pictures of badges that can be earned upon meeting step goals. The learn section contained culturally tailored behavior change articles.

Usability testing

Round 1

Several of the eight participants noted that manually entering an exercise bout was not intuitive and therefore, they were not clear how to utilize this feature. They also reported a desire to be able to enter specific types of PA themselves. The men reported liking the tracking feature, that the app was specifically designed for African American men, and the ability to input health parameters. The app was modified following Round 1 usability testing by altering the color scheme and adding a "Learn", or "Help", component to ease navigation and utilization of the various components. We also presented a list of 15 badges (e.g., "Trail blazer" with a shoe print, "Go Hard" with an image dunking basketball, "Power" with a black hand holding lightning) to these participants and had them rate their liking of each badge along a scale of 1 (strongly dislike) – 5 (strongly like). We selected the six badges with the highest ranking and these were the badges shown to participants in subsequent rounds.

Round 2

The men (n=5) noted that they would change the look of the app (e.g., less white space, less blocky, etc.) and have a FAQ. The men liked the badge concept, but suggested changes (e.g., badge competitions, personalization, animation) and badge alterations (e.g., increased number of badges available). Strengths of the app included the ability to sync with the Fitbit, tracking of health parameters, notifications, specificity to African American men, culturally tailored articles, and ease of navigation. The app was altered to reduce white space and decrease the use of horizontal lines to improve visual appeal following Round 2 usability testing. The incorporation of competition, personalization, energy expenditure from activities, and communication with other men were beyond the budgetary scope of the current project.

Rounds 3 & 4

The men (n=6) reported wanting to see graphs of their PA and to be able to longitudinally track information on health parameters (e.g., blood pressure, weight, cholesterol, etc.) and other types of PA (e.g., weight training, Zumba, yoga, etc.). They also expected to see information covering exercise tips, video demonstrations, PA resources, specific PA for chronic diseases, and nutrition information. The badges, tracking, and tailoring to African American men were the features most frequently liked by the participants. Further work to modernize the look of the app, incorporate nutrition information, and exercise tips were conducted following each round. In addition, we provided information on nutrition and exercise tips through notifications due to the frequent request for this information. The ability to track health parameters longitudinally and add badge animation were beyond the budgetary scope of the current project.

The average score for the SUS across the four rounds was 74.7 indicating that the men found the app easy to use and intuitive. Scores for rounds 1–4 were 70.6 (12.4), 75.5 (13.5), 85.0 (6.6), and 74.2 (17.0), respectively. User-friendliness scores for rounds 1–4 were 4.3 (1.0), 4.8 (1.3), 5.6 (0.6), and 5.0 (0.0), respectively, with the average being 4.7 (1.0).

MobileMen app

The *MobileMen* dashboard allows the participant to enter their name, age, weight, blood pressure, glucose, and cholesterol. The men were given a Fitbit® to wear during

Figure 2 Screenshot of *MobileMen app*.

field usability testing (see below). The *MobileMen* app imports data from Fitbit activity monitors. The actual steps taken, percent progress towards the goal, and bar graphs (for the previous 7 and 30 days) are displayed in the dashboard. The goal progress circle displays in gray until the goal is met at which time the circle becomes green. The bar graph is also color coded to represent step counts below baseline (red), between baseline and the goal (blue), and at or above the goal (green). The Activity page allows men to self-report the date, type, and time spent engaged in PA. The page also displays the activities recorded from the Fitbit including runs, sport, walks, etc. The app includes six different badges, or achievements that can be earned (*Figure 2*). The badges can be earned for achieving 10,000 steps in any week (Rookie), 10,000 steps at least 3 days in 1 week (Pro), 10,000 steps at least 3 days a week for 3 weeks (Elite), or for reaching 15,000 (MVP), 25,000 (Dominate), or 35,000 (Beast Mode) steps in any given day. All badges are displayed with a gray circle enclosing a question mark and the criteria needs to be reached before each badge will display beneath. All badges show in color when the badge is earned.

In addition to the badges, the *MobileMen* app includes four culturally tailored articles available for the men to read that provide behavioral strategies for maintaining a PA routine. Each article describes a behavioral strategy (e.g., problem solving), provides an example of an African American male utilizing the behavioral strategy (e.g., Darryl Strawberry problem solving drug addiction) or an example from African American worldview (e.g., African American concept of friends viewed as family), and depictions of African American men. Each week a new article (<600 words) becomes available in the following order: Problem Solving, Ways to Stay Motivated, Social Support, and Relapse Prevention.

The *MobileMen* app contains a weekly notification system. Participants are sent 6 notifications per week (total 24) related to 6 different categories; lesson content, activity prompt, motivational message, Fitbit wear prompt, nutrition tip, and a tailored message. The tailored message is based on the number of steps taken during the previous week. If the participant took less than the goal step count 4 out of 7 days, they received a message that contained behavioral strategies for increasing activity (e.g., "You almost reached your activity goal yesterday. Try to schedule in specific times for physical activity tomorrow."). If the men reached their step count goal 4 out of 7 days, they received a congratulatory notification (e.g., "Keep up the good work."). The men could receive an additional notification for every badge they earned, for a total of 6 extra notifications over the course of the month.

Feasibility study

Because the goal of the app is to promote PA maintenance, the feasibility study (i.e., beta test) of the *MobileMen* app was conducted in the Baton Rouge area with 10 African American men who self-reported regular PA. The men utilized the app for one month. During the initial visit, participants were provided a Fitbit, assisted in downloading the app onto their device, received an individual app tutorial, and were scheduled to return one month later. The data showed the men wore the Fitbit on 262 of 280 days (93.6%; daily step count above 1,000). The men averaged 7,267.7±3,249.6 step counts per day with an average range of 4291 to 14821 over the course of the month. There was no change in steps per day (P=0.848) over the course of the study. The men were sent between 25 and 28 notifications.

The men accessed the app between 8 and 60 times and had an average of 27.8 log-ins per participant. The men utilized the app between 2 and 191 minutes and had an average of 74.5 minutes spent on the app over the course of the month. Only one participant attempted to self-report activity via the app. Every participant earned at least one badge. The most frequently earned badges were Rookie (10 men) and MVP (6 men). No men earned the Dominate or Beast Mode badges. The articles were accessed a total of seven times and for less than two minutes per access. We assessed if app usage was associated with step count data. There was no significant association between app usage and step difference (r=0.06, P=0.874) nor app use and the "fairly active" (Fitbit category) difference (r=0.06, P=0.873).

The satisfaction survey showed that individual questions related to the helpfulness and enjoyment of the articles were deemed below acceptable (mean values <3.5). Summary scores for the various app components ranged from 3.7 (articles) to 4.3 (activity tracking). One question each assessed overall satisfaction with the app (mean =3.7), the Fitbit (mean =4.8), and preference of using a mobile intervention over other methods (81.8% responded "Yes").

Discussion

MobileMen is one of the first studies to document that African American men specifically are willing to utilize apps to improve their physical health in general and specifically to promote and sustain PA behaviors. In this paper, we document the iterative process used to development a PA maintenance app for African American men. This pilot study showed that the app is feasible, but also indicates areas of improvement in order to develop an ideal app for this population.

Importantly, African American men recognize that food intake is inextricably tied to PA and health. The desire for nutrition information and planning to support a PA regimen was a concept that was raised in all focus groups and usability testing. In order to address this need, nutrition information was included as notifications in the *MobileMen* app. These were essentially nutrition tips that promoted healthy food intake, but we did not provide recipes, caloric counts, meal plans, or specific nutritional planning based on the PA routine or health condition that men may be experiencing. The need for dietary information also suggests the men are very aware of the fact that nutrition plays a vital role in health. Finally, this information indicates that a PA app on its own is not likely to be comprehensive enough for this population to use above currently available apps. This is further supported by the fact that the men indicated that an app needs to be all-inclusive. Therefore, an app that this population is likely to utilize will need to have interrelated dietary, PA, and chronic disease information. The *MobileMen* app platform allows for the incorporation of these and other behavior change elements in future iterations.

The feasibility study indicated that the app as developed is acceptable. The men accessed the app on average once per day, reported being satisfied with the app, were compliant with Fitbit wear, and they were satisfied with utilizing the Fitbit, yet our findings suggest that there are aspects of the app that can be improved. Participants did not read the articles, provided neutral ratings on their liking and perceived helpfulness of the articles, and did not utilize the self-report PA feature of the app, though some specifically requested this option. There were no changes in PA across the feasibility study period nor was app use associated with step data, but this is expected as the app is designed to maintain PA in African American men. Future work can assess these relationships to determine the features that are most beneficial in this population.

These findings suggest several possible alterations to the app. First, the men are unlikely to utilize features that require active input, such as self-reporting PA. However, this component adds information that is not captured by activity monitors. Therefore, investigating ways to improve usability of these kinds of app components is warranted. Second, static information (e.g., behavioral articles) are also unlikely to be accessed. It may be that men will read the information when they feel a need to learn about ways to change behavior (i.e., pull) rather than have information provided to them (i.e., push), and therefore providing the information in a format that allows the men to access it at their request (e.g., archive) may elicit more use. In addition, data derived from the usability testing suggests that PA information may be better communicated through videos and that providing short articles on a wide variety of topics (e.g., chronic diseases disproportionately affecting African American men, PA resources, etc.) may garner more interest. Alternatively, an algorithm can suggest which articles may be relevant to their PA habits based on performance or via an advanced "help" menu. Third, the men appreciated tracking of activity, but the app may need to be modified to work with several wearables as opposed to only the Fitbit, as some men suggested.

The men noted a number of elements that are important

to include in an app developed specifically for African American men. These sentiments are consistent with data from qualitative studies that have documented facilitators of African American men's health behavior change (47,48). Based on the number of suggested elements, we decided to create an app that had greater breadth (i.e., including badges, notifications, lessons, self-monitoring) as opposed to greater depth (e.g., a large number of badges, badge animation, etc.). Several of these elements were able to be incorporated into the app, including (I) depictions of African American men, (II) the naming of and images of the badges, (III) tracking of specific health parameters that represent health disparities for African American men, and (IV) information on healthy eating because participants noted that African American men lack information on health eating. Some other cultural elements would be more difficult to incorporate into the app, including competition, accountability, and incentives, because they require more resources than available in a Phase I prototype. Future studies should include more exploration of these ethnic and gendered cultural elements.

There are a number of commercial PA promotion apps on the market. The *MobileMen* app is unique among these other commercial platforms because it contains the following elements in one app. First, *MobileMen* is the first app that we know of that is focused on maintenance of behavior change in African American men. Second, *MobileMen* is tailored to African American men. Third, *MobileMen* provides for tracking of health parameters. Fourth, the app provides behavioral change strategies that incorporate African American culture to increase saliency. Fifth, the app is based on behavioral theory. Some features, such as self-monitoring and goal setting are common among apps, yet are necessary components in any behavior maintenance product. Future work will continue to add features and elements that were explicitly requested by African American men to enhance novelty, tailoring, and ideally, effectiveness.

The study has a number of strengths. The app was developed with input from the target population, African American men. An iterative design was used where qualitative data was used to refine the app continuously over a number of cycles. Behavioral theory was incorporated through self-monitoring, goal setting, feedback, behavioral strategies, among others. There are also some limitations. We did not collect demographic data beyond age. However, while these factors are interesting and help to more fully inform on the population that was assessed, they are unlikely to have a large impact on the outcomes and the men's beliefs about a smartphone app for maintaining PA. The app did not include all of the elements that African American men deemed relevant because the budget and timeline did not allow for all desired changes to be made. However, the app was still viewed as satisfying. The app was developed specifically by African American men residing in the Southern U.S. These elements may limit generalizability to men and African American men in other regions of the country. However, it is important to show feasibility in one region before generalizing to other environments, and given chronic disease health disparities, there is a need for interventions specifically developed for this population. Finally, the study was conducted over a very short period of time and was composed of a small sample size.

Our study was one of the first to document the development of a mHealth app for African American men targeting PA. The current study showed that African American men are willing to utilize mHealth technology to address chronic disease health disparities. The study also documented the systematic development of a PA maintenance app that showed acceptability in the target population. There are a number of other app features that can be incorporated into the app to further tailor it to an African American male population.

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Footnote

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Ethical Statement: All procedures were approved by the Pennington Biomedical Research Center Institutional Review Board.

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Supplementary 1 Focus Group 1 Script

Project background and overview

Hello and thank you for joining our focus group. My name is <<name of facilitator>> and I work here at Pennington Biomedical. We've asked you all here to help us create a useful smartphone application that can help you with your physical activity habits. African American men exercise at levels that are below what the government recommends. So the idea behind the MobileMen smartphone application is to help African American men find ways to initiate and sustain physical activity habits. We're seeking your input on the importance of physical activity, the idea of utilizing a smartphone app to accomplish physical activity goals, any features that you feel would be necessary in a smartphone app.

Introduction

Have participants introduce themselves by first name only.

Focus group discussion

1. What types of thoughts come to mind when you think about exercise?
2. How important is it for you to be physically active?
3. What prevents you from exercising regularly?
4. What barriers do you face when you try to maintain a physical activity program?
5. What do you need in order to maintain a regular exercise regimen?
   a. Prompts: Time/$/support/motivation/strategies
6. Do you use mobile phone apps?
   a. If so, which type of apps do you use?
   b. If not, why not? What would make an app appealing to you?
7. Describe your experiences using mobile phone apps.
   a. What about the app made it useful?
   b. What about the app was problematic?
8. How well do you think a mobile phone app would help you to maintain your physical activity habits?
   a. How well would it help you initiate a physical activity program?
   b. How well would it help you maintain a physical activity program?
9. What features would an app need to have in order to help you maintain a physical activity program?
10. What kinds of features would an app need to have in order for you to continuously use it to maintain your physical activity habits?
    a. Prompts: content/look/usability
11. What aspects about your demographic would be necessary to include in the app to make it specifically tailored to you?
    a. Prompts: environment/gender/age/ethnicity/employment/marital status/

Supplementary 2 Lab Usability script

Introduction

Hello and thank you for participating in our lab user test. My name is <<name of test moderator>> and I work at Pennington Biomedical. (Introduce anyone else in the room and their role.)

We've asked you to help us create a smartphone application meant to help black men maintain and track their exercise habits.

At this point the mobile application is in the early phase of development. The purpose of this testing is to see if you think the features ae what you expected and whether they are useful.

We are looking for feedback on the features and their usefulness. I'll also be watching for functional glitches in the app. The more you talk aloud about thoughts and interactions with the app, the more we will learn. Tell us what you are looking for, which ones are useful, whether anything is useless, and what might be missing. We encourage you to be honest. We are not the programmers and all of your feedback will count towards making the app better.

During this session we will be watch what you're doing and looking at the screen and your eye movements. For this type of testing, we want to see what is natural for you, so there may be a few points where we don't answer you right away – this is so we can see if you can figure it out first. Again, this is for us to see what features are useful and whether they are what you would expect in an app like this. Ultimately, we want this to be as natural as possible.

Do you have any questions right now?

Ok, let's get started.

Usability testing (sample follow up directions/questions)

Imagine you have been using the *MobileMen* app for a week or two. You are opening the app to view your exercise progress. Where would you go to find this information?

- Show us how you would use these graphs to explore.

Show us where you would go to manually enter an exercise bout.

- Go ahead and enter the last time you exercised.
- Is there anything else you would like to comment on for the Activity feature?

Show me where you would go to find the badges you earned within this app.

- What do you think of this feature?

Imagine you are interested in learning more about ways to maintain your exercise habits. Where would you go to find this information?

- How would you view an article on this page?