

Development of the Physical activity and Your Nutrition for Cancer (PYNC) smartphone app for preventing breast cancer in women

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Background: In the U.S., breast cancer accounts for more cancer deaths in women than any site other than lung cancer. Based upon attributable risks, about 30–35% of breast cancers could potentially be prevented by addressing obesity, physical inactivity, increased alcohol consumption, and carcinogenic exposures such as hormone replacement therapy (HRT). We need methods of reducing women's risks of this disease that are attractive and easy to use, widely accessible to diverse women, and able to be easily amended to account for new research.

Methods: The overall objective of this 12-month project is to develop and test a smartphone app to provide women with information about how they can reduce their risk of breast cancer through healthy behaviors such as physical activity, weight management, restricting caloric intake, consuming a healthy diet and proper nutrition, engaging in regular physical activity, and avoiding carcinogenic exposures such as HRT and alcohol. The specific aims are: (I) to develop a smartphone app for breast cancer prevention using a behavioral framework; (II) to ensure interconnectivity with commercially available products (Fitbit device for monitoring physical activity and the LoseIt! smartphone app for monitoring and tracking diet and nutrition); and (III) to ensure that the mHealth intervention is suitable for women with varying levels of health literacy and eHealth literacy.

Results: The app, referred to as Physical activity and Your Nutrition for Cancer (PYNC), is being coded on an iOS platform. Users will be able to access the breast cancer prevention app using their smartphone or tablet. The app's design will ensure interconnectivity with commercially available products for monitoring and tracking physical activity, caloric intake, diet and nutrition. Using the app, it will be feasible for users to connect and sync their Fitbit and LoseIt! accounts so that information collected about physical activity, caloric intake, diet, and nutrition can be conveniently assessed from one portal. The Fitbit device and app provides reminders and allows users to set physical activity goals. Users will be able to access health education information about breast cancer risk-reduction with attractive graphics and visual displays.

Conclusions: Future directions will include testing the efficacy of the mHealth intervention in increasing physical activity, improving diet and nutrition, and weight management through a randomized controlled trial, and widespread dissemination and implementation research.

Keywords: Alcohol; apps; breast cancer; diet; health literacy; mHealth; nutrition; obesity; physical activity; primary prevention; smartphones

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Introduction

A variety of modifiable risk factors for breast cancer have been identified in epidemiologic studies including increased alcohol consumption, physical inactivity, obesity, exogenous hormones, and certain female reproductive factors (1,2). Parity and older age at first full-term pregnancy may influence breast cancer risk through long-term effects on sex hormone levels or by other biological mechanisms. The high prevalence of obesity in the U.S. population is a serious threat to women's health because of causal linkages between obesity and cancer of the breast, colon, and other sites, and other adverse health consequences (3,4). In epidemiologic studies, obesity has been found to have a dose-response relation with breast cancer risk among post-menopausal women (5,6). Nutrition, physical activity, and energy balance are important determinants of weight loss and maintenance of healthy weight. However, approximately 35% of adults in the U.S. are obese (7). Based on data from the 2013 BRFSS survey, only half of U.S. adults (50.2%) met guidelines for physical activity and an additional 11.7% only partially met the guidelines. Women are less likely than men to meet guidelines for physical activity (48.6% *vs.* 52.5%). Evidence from epidemiologic studies indicates that high levels of physical activity reduce breast cancer risk in women (8). The possible biological mechanisms include the influences of physical activity on body composition, insulin resistance and circulating levels of sex steroid hormones (9).

Based upon attributable risks, about 30–35% of breast cancers could potentially be prevented by addressing obesity, physical inactivity, alcohol consumption, and hormone replacement therapy (HRT) (10,11). Results from the Women's Health Initiative Randomized Trial indicate that HRT after menopause increases breast cancer risk (12–14). Use of a regimen that includes both estrogen and progesterone has been associated with a higher risk of breast cancer than the use of estrogen alone (15).

Rapid advances in mHealth and social media technologies are contributing to a burgeoning number of novel health promotion and public health interventions for preventing and controlling breast cancer and other chronic diseases (16–22). Examples include cellphone text messaging and smartphone apps for cancer screening; weight management through caloric restriction, healthy diet and nutrition, and physical activity, and helping

consumers to avoid carcinogenic exposures at home and in the workplace (16–22). Other research has examined mHealth interventions for African American breast cancer survivors who are interested in lowering their risk of cancer recurrence through healthy lifestyle changes (23).

Over 86% of U.S. adults use the Internet (24). About 58% of U.S. adults owned a smartphone in 2016 and the percentage is projected to surpass 90% by 2020 (25,26).

Few published studies have examined the health literacy levels of educational information provided via mobile apps. For mHealth interventions to be useful for encouraging healthy behaviors and weight loss, they must be suitable for people with varying levels of health literacy, eHealth literacy, computer literacy, and scientific literacy (18).

In parallel with these developments are rapid advances in relatively low-cost wearable devices that assist consumers to monitor their physical activity and become more active (22,27–33). Devices such as the Fitbit and Jawbone have the ability to objectively measure a variety of activity-related outcomes including steps, distance, heart rate, active minutes, calories, and sleep. Additionally, users can access the Fitbit app and web interface to socialize with friends and complete group challenges. Fitbit devices have shown high validity and reliability (ICC 0.71–1.00) (34–36) and a growing amount of research has successfully incorporated Fitbits into technology-oriented lifestyle interventions to increase physical activity, reduce overweight/obesity, and manage chronic conditions such as cancer (22,27–33). Users can track total minutes of physical activity, steps, and floors climbed per day enabling them to receive feedback on their activity.

The overall objective of this 12-month project is to develop an app to provide women with information about how they can reduce their risk of breast cancer through healthy behaviors such as physical activity, weight management, restricting caloric intake, consuming a healthy diet and proper nutrition, and avoiding carcinogenic exposures such as HRT and alcohol. The specific aims are: (I) to develop the app for breast cancer prevention using a behavioral framework; (II) to ensure interconnectivity with commercially available products (Fitbit device for monitoring physical activity and the LoseIt! smartphone app for monitoring and tracking diet and nutrition); and (III) to ensure that the mHealth intervention is suitable for women with varying levels of health literacy and eHealth literacy. The literacy level of information included in the app will be suitable for women who have at least an 8th grade education.

Methods

Development process

To ensure that the intervention materials that are being developed are appropriate for the intended audience, we are employing an 8-step process (37,38). Development to date has included literature reviews, conceptual design, drafting informational and motivational content, acceptability review with community members, and scientific review by the research team. Sample content was reviewed by a convenience sample of five women in Seattle, WA and Augusta, GA who had agreed to be part of a Community Advisory Board for a future phase of this community engaged research, who were interested in breast cancer risk reduction. After incorporating their feedback, a beta version is now being coded with minimum necessary content and basic navigation elements. Remaining steps include prototyping materials, assessment of health literacy level, usability testing with community members, and final modifications. The prototype app will be subjected to heuristic evaluation and pilot testing. Evidence-based heuristics will be used to evaluate the demands that the mobile app makes on users, in terms of health literacy and usability, i.e., the extent to which the app is practical and convenient for users (18,39). The heuristic evaluations will provide rapid, low-cost assessments that will help to improve the usability of the app, prior to conducting testing with research participants (39). Once the beta version is available for usability testing, ten additional women will be given two weeks to try out the app in concert with the Fitbit device and LoseIt! app. Following this period, they will be asked to provide feedback by phone using a semi-structured interview to evaluate the relevance, acceptability, credibility, and comprehensibility of the information and interface. Ten additional women will be recruited for final usability testing of the final beta version of the complete intervention through one-on-one, in person meetings. Discussions will elicit informants' feedback on content, word choices, images, and general look and feel of intervention materials to ensure that they are user-friendly and easy to understand. Sessions will last for 2 hours and be digitally recorded.

Intervention technology and connectivity to other devices

The app is being developed on an iOS platform. Users will be able to access the breast cancer prevention program using their smartphone or tablet. The app's design will

ensure interconnectivity with commercially available products (Fitbit device for monitoring physical activity and the LoseIt! smartphone app for monitoring and tracking diet and nutrition). Using the program, it will be feasible for users to connect their Fitbit and LoseIt! accounts so that information collected about physical activity, caloric intake, diet, and nutrition can be conveniently assessed from one portal. Users will be able to access health education information about breast cancer risk-reduction with attractive graphics and visual displays and the program will incorporate interconnectivity features that allow users to monitor and track their physical activity, caloric intake, diet, and nutrition using their Fitbit device and LoseIt! app.

Intervention behavioral theory

We have used Leventhal's Common Sense Model of Health Behavior, which describes how thoughts and beliefs about health and disease risk influence behavior (40,41). This model is ideal for smartphone app interventions because it emphasizes the ways in which people actively cope with information about their health and make decisions regarding healthy behaviors, incorporating the importance of their emotional reaction to a health risk. According to this individually-based model, a person begins coping with risk for breast cancer when she learns about risk for the disease. The person has an emotional reaction and develops an internal understanding, or mental representation, of what risk for breast cancer means. This representation will include general knowledge and beliefs about breast cancer and, more specifically, beliefs about personal susceptibility to the disease. Emotional variables include the person's specific reactions to breast cancer and breast cancer risk and will in turn influence both the individual's mental representations and their action plan. The action plan may include consideration of several approaches including arrangement for physician's visits for screening, other personal behaviors (such as dietary changes), and/or avoiding thinking about risk. Our addition to this model is a series of variables on communication among networks of family and friends. In keeping with data on the importance of communication in health decisions (42,43), we propose that communication among family and friends, including the content and frequency of breast cancer-related communication, influences individuals' thoughts and feelings about breast cancer risk and ultimately, their prevention behaviors. This influence may be positive (i.e., supporting screening) or negative.

Intervention content

The mHealth intervention will provide information, cues, and prompts, and problem solving. An example of the latter is offering low-cost, healthy menu suggestions for people on a budget. By including educational information about modifiable causes of breast cancer (e.g., the potential benefits of weight loss through healthy eating, caloric restriction, limiting alcohol intake, and physical activity), the breast cancer prevention program will incorporate elements of the Health Belief Model (HBM) (44). The HBM posits that a person's beliefs about a health concern such as breast cancer, their perceived benefits of an action (e.g., adopting a healthy diet, engaging in physical activity, avoiding alcohol) and barriers to action, and self-efficacy explain engagement in health promoting behavior (44). The HBM suggests that a stimulus or cue to action must be present to trigger health-promoting behavior. Connectivity with the Fitbit device and LoseIt! app will provide several triggers to promote healthy behaviors. For example, the Fitbit device prompts physical activity behavior by buzzing every hour of the day that 250 steps are not achieved. Users will also be able to record minutes of physical activity per day enabling them to receive instant feedback on their energy expenditure. The LoseIt! app provides information about practical steps that can be taken to lose weight including menu suggestions. The app allows users to set a weight loss goal and to self-monitor daily energy intake toward achieving that goal and serve as a cue for action. The LoseIt! app also allows users to set a weight loss goal.

The breast cancer prevention app will include evidence-based information about breast cancer and ways that women can reduce their risk of the disease provided by the National Cancer Institute, the Centers for Disease Control and Prevention, and the American Cancer Society (ACS) (45). The program will stress the importance of consuming adequate amounts of fruit and vegetables, selecting whole grains and fat-free and low-fat dairy products, and avoiding or limiting red meat, processed meats, saturated fats, added sugars, and refined grains. Dietary guidelines will be followed that were developed jointly by the USDA and the Department of Health and Human Services (HHS) (46). In addition, information about healthy eating will be provided that is based upon the ACS guidelines on nutrition and physical activity for cancer prevention (45,47) and the World Cancer Research Fund/American Institute for Cancer Research nutrition-related recommendations for cancer prevention (48,49).

The program will also utilize information and graphics from the USDA's ChooseMyPlate program which provides practical information to help consumers build healthier diets with user-friendly nutrition information (50). The information will include healthy recipes through links to external sources. Physical activity guidelines will be followed that were developed by HHS and ACS. The 2008 Physical Activity Guidelines for Americans emphasize that all adults should avoid inactivity (51). Some physical activity is better than none, and adults who participate in any amount of physical activity gain some health benefits. For substantial health benefits, adults should do at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Aerobic activity should be performed in episodes of at least 10 minutes, and preferably, it should be spread throughout the week (51). The program will include health messages about the importance of routine physical activity for weight management and the potential health benefits. Educational information will also be provided about breast carcinogens (HRT, alcohol consumption). In addition, information will be provided about the importance of routine screening mammography for early detection of breast cancer following evidence-based screening recommendations from the US Preventive Services Taskforce and the American Cancer Society (52,53).

Narrative text will be supplemented with graphical displays and tabulated information. Varying levels of eHealth literacy will be addressed by using simple navigation features and providing straightforward instructions about how to use the app and connect it to commercially available products (Fitbit watch and LoseIt! app). Women who lack basic computer and Internet skills will be least likely to benefit from the app. However, many consumers already use a variety of apps on smartphones and other portable devices. Further, it will be possible for women to use the app without interfacing with Internet sites provided by Fitbit and LoseIt!

The prototype app is currently being coded and has not yet been tested in human subjects research involving a research protocol reviewed and approved by an institutional review board (IRB). The 5 women who were asked to review and comment on sample content (i.e., narrative text about healthy eating, diet, physical activity, weight management, etc.) had agreed to be part of a Community Advisory Board

for a future stage of this community engaged research. Future directions such as usability testing of the app itself and testing the efficacy of the mHealth intervention in increasing physical activity, improving diet and nutrition, and weight management through a randomized controlled trial, will require IRB review and approval and informed consent.

Results

Several themes emerged from the feedback on the narrative text on breast cancer prevention which was offered by a convenience sample of five women in Augusta, GA and Seattle, WA. One theme reflected in their comments was that the text on healthy diet and nutrition had redundancies and was too lengthy. Based upon their feedback, information about healthy diet and nutrition has been separated into primary and secondary information and redundancy reduced. One of the reviewers recommend “*more relaxed language*” and that “*some information be presented in a more visual way*”.

Another theme was that it would be helpful to provide suggestions for easy-to-prepare healthy foods. A reviewer noted: “*everyone is feeling overloaded, spending too much time working and not enough time on basic human needs, like nutrition. So some inspiration is needed here. Nutrition needs to become easy and somewhat fun... Things you can just throw together.*” Also, “*suggestions for shopping and arranging your refrigerator.*”

A further theme was the value of providing information about how to read food labels. One reviewer noted, “*show the deceptions on labels. Encourage people to move beyond the big print on the front of the package... Low fat, non-fat and natural doesn't necessarily mean it's good for you or it's low in calories.*”

Some of the women wanted more information about environmental contaminants and chemicals that may influence cancer risk such as cleaning products and beauty products.

Discussion

The app intervention will be innovative in several ways. We are aware of no published studies on the use of mHealth interventions for promoting healthy diet, nutrition, physical activity, and weight loss among women at-risk of breast cancer who have varying levels of health literacy and e-health literacy. The app will address the need for low-cost, effective strategies for weight loss for at-risk women.

The app will be developed using evidence-based approaches for breast cancer risk-reduction and it will be informed by behavioral theories.

Cancer prevention and control messages are often written at too high a reading level for individuals with marginal literacy skills (54). Health literacy is comprised of numerical literacy (numeracy), print literacy, and conceptual knowledge (55,56). eHealth literacy is the ability to seek, find, understand, and appraise health information from electronic sources and apply this knowledge gained to addressing a health problem (56). eHealth literacy is comprised of both general skills and specific skills. General skills include reading, writing, and numeracy; media literacy, and information literacy (i.e., information seeking and understanding). Specific skills include computer literacy (information technology skills), health literacy, and science literacy (56). eHealth literacy involves a mix of health, information, scientific, computer, and Internet literacy (56). Rather than being static, both health literacy and eHealth literacy are influenced by an individual's health status, motivation, education, and changes in technology (56,57).

With respect to limitations, the app that is being developed is not tailored for specific groups of women such as those who are African American or Hispanic. Future research could include the development and testing of breast cancer apps that are culturally tailored for important subgroups of the population. In addition, apps are needed that meet the needs of breast cancer survivors. The American Cancer Society and the National Cancer Institute recently released an mHealth resource, Springboard Beyond Cancer, which is designed to improve cancer survivor self-management. However, it does not focus specifically on breast cancer. Further, substantial information is included about the acute treatment phase which may not appeal to women who were treated for breast cancer years in the past and who wish to focus on healthy lifestyle and quality of life.

A strength of the mHealth intervention for preventing breast cancer in women is that it will draw upon commercially available technology for monitoring physical activity, caloric intake, diet, and nutrition, while providing evidence-based information about breast cancer and ways that women can reduce their risk of the disease. It will be feasible to edit the program content as new scientific information becomes available about breast cancer prevention and modifiable risk factors for the disease. Future directions are likely to include testing the efficacy of the mHealth intervention in increasing physical activity,

improving diet and nutrition, and weight management through a randomized controlled trial, and widespread dissemination and implementation research.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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