Designing a Sociotechnological Intervention to Improve Snacking in Low Socioeconomic Families

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Abstract

Low socioeconomic (SES) populations face high risks of acquiring chronic diseases including cardiovascular disease, diabetes, hypertension, and high blood pressure. The leading causes for these risks include poor diet and lack of physical activity. While conducting a needs assessment with a low SES population, we discovered that unhealthy snacking habits contribute heavily to their poor diet. In this paper, we report the design of four mobile phone-based prototype applications that aim to improve the snacking habits of the target low SES families. We present the behavioral change theories that serve as the building blocks for the prototypes, and discuss how the prototypes will be evaluated using participatory and user-centered design techniques. We conclude by discussing a future study that includes a one-month field trial and pre- and post- intervention photo-elicitation interviews to determine the effectiveness of the prototype.

Introduction

Low socioeconomic status (SES) populations have the highest risk of acquiring chronic diseases including cardiovascular disease (CVD) and diabetes^{1,2}. A study showed that 87% of the children from a low SES population were exposed to at least one modifiable CVD risk factor. Poor diet and lack of physical activity were the major causes¹. We conducted interviews with the same population and found that individuals wanted to change their health habits, but did not necessarily have the financial, social, and strategic resources to support this change³. We confirmed results from the needs assessment studies by exploring their everyday dietary habits, and found that unhealthy snacking had a significant negative impact on their diet. Although many nutrition monitoring applications have been developed by commercial (calorieking.com, mealsnap.com) and academic^{4,5} sectors, these applications did not take into consideration the social, cultural, and economic needs of low SES populations.

For this research, we will design and evaluate four mobile phone-based prototypes to improve the snacking habits of the target population. Not only do the prototypes provide individuals the ability to capture and track their snacking information, but they will also have the potential to motivate people to eat healthy snacks and provide them feedback based on their current snacking habits. The prototypes, based on established behavioral change theories, will engage the entire family by presenting them with snacking history and family-based diet comparisons. Moreover, we designed two prototypes as gaming and two as non-gaming applications to explore whether the target population is motivated to improve their diet by playing healthy snacking games. We will evaluate the four prototypes by engaging the low SES families to participate in user-centered design activities including task-based usability evaluation, semi-structured interviews, and survey questionnaires.

Our research will contribute to the area of health informatics by providing guidelines to design sociotechnological interventions for low SES populations to improve their snacking habits. In the future, the optimal prototype design will be developed into a functional prototype and evaluated with the target population for a month-long pilot intervention study. For the functional prototype, we will explore innovative mechanisms to encourage family-based long term use, and store the snacking information in a life-long sharable Personal Health Record (PHR).

Target Population

The target population for this research will be recruited from the Bridge Project - a community outreach program that serves over five hundred families in four Denver public housing neighborhoods. Most of these families are from diverse ethnic groups and live below the poverty line. The Bridge Project offers educational programs to children aged three to eighteen for their K-12 curriculums. We have volunteered as tutors for middle school and high school students for more than fifty hours to keep a strong, trusting relationship with the Bridge Community.

Background

As part of the needs assessment, we conducted a Multimedia-Elicitation Interview (MEI) study where we provided camera phones to eight caregivers from the target population and asked them to capture pictures and videos of anything that reminded them about health. We found that the target population's perceptions about health predominantly related to their diet since most of the multimedia content was about food, especially meals and cooking. Unhealthy snacking habits contributed to the poor diet of the low SES families. We also found that culture and family-based practices were deeply ingrained in participants' health related activities. These findings informed the idea of designing a family-based intervention where the entire family participates in the sociotechnical intervention to improve their snacking habits. The study also revealed that the participants did not understand dietary nutritional components (e.g., carbohydrates, proteins), but had a general idea of good and bad foods. When we discussed the potential of a sociotechnological intervention with participants, they mentioned that mobile phones would be the most appropriate platform because they were portable and everyone owned them.

Proposed Approach

The results of the needs assessment study showed that unhealthy snacking is among the causes for poor diet in the low SES families. In an attempt to assist families improve their snacking habits, we will conduct a study to evaluate four prototypes (2 gaming and 2 non-gaming) to explore which snacking visualizations are intuitive for the target population and which designs they prefer. We will employ different user-centered design techniques including semi-structured interviews, questionnaires, and usability assessment methods to evaluate the prototype designs. Since all prototypes are based on established behavioral change theories, we briefly summarize the theories used.

Health Belief Model (HBM): The HBM illustrates that an individual may change her behavior to prevent an illness based on threat perception and behavioral evaluation⁶. The threat perception includes beliefs in perceived susceptibility and assessment of the severity of the illness. Similarly, behavioral evaluation includes beliefs in perceived barriers and perceived benefits of performing the behavior.

Social Cognitive Theory (SCT): The SCT describes how individuals' perceived self-efficacy coupled with sociostructural factors and outcome expectations affect the individuals in achieving their goals and inducing behavioral change⁶. The perceived self-efficacy is influenced by personal accomplishment, vicarious experiences, verbal persuasion, and emotive sources. SCT also established that individuals learned from experiences of other people and did not merely copy their behaviors; instead, they exhibited modified behavioral patterns.

Elaboration Likelihood Model (ELM): The ELM describes how low elaboration and high elaboration affect individuals' attitudes towards a persuasion⁶. The persuasion may be achieved through a great deal of thought (the central route), or through a lower cognitive processing (the peripheral route). Attitudes achieved through the central route are more stable and permanent, while the attitudes formed by the peripheral route are more susceptible to counter-persuasion.

Precaution Adoption Process Model (PAPM): PAPM is a stage theory that categorizes an individual's behavior in seven different stages⁶. The PAPM stages include (1) unaware, (2) unengaged, (3) deciding about acting, (4) decided not to act, (5) decided to act, (6) acting, and (7) maintenance.

Prototypes

The prototypes are designed for touchscreen-based mobile phones because the needs assessment revealed that the participants wanted the technological intervention on a mobile phone. All the prototypes have some basic features in common that provide users the ability to: (1) enter snacks; (2) receive feedback on snack healthiness; (3) view individuals' snacking history; and (4) view family snacking healthiness. The first two prototypes discussed below are non-gaming, while the last two are gaming applications. All the prototypes were internally evaluated and modified using multiple cognitive walkthrough⁷ iterations.

Snack Manager: The Snack Manager prototype (Figure 1), based on SCT and HBM, is designed to capture and display multiple users' snacking information. The design of the Snack Manager prototype is informed by our needs assessment where we found that the low SES families did not want to waste food and risk money on new food

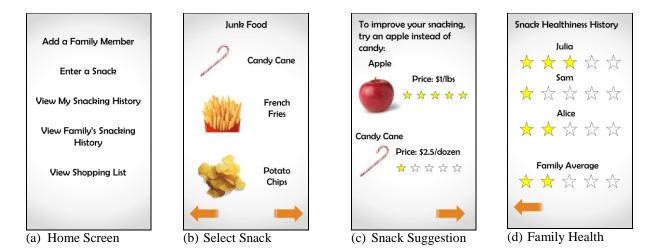
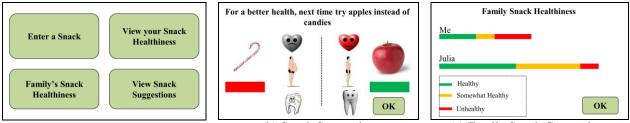


Figure 1. Snack Manager Prototype

items³. Based on these findings, the prototype provides suggestions to users within a price threshold to replace their current snack with a healthier snack. The healthier snack is either within the same product category as the current snack or it is a snack that the low SES families prefer. Additionally, family members can compare the healthiness of their snacks with each other.

The home screen, shown in Figure 1a, displays options to add a family member, enter a snack, view family snacking diet, view snacking history, and view shopping list. The user can enter his name or a family member's name into the system. Before entering the snacks, the user can select the family member whose snacks he wants to manage. Once the user selects the desired profile, Figure 1b is displayed, where the user can select the snack from predefined snack categories. The system records the input, and presents the user with a healthier suggestion to replace his current snack within a predefined price threshold – as shown in Figure 1c. The snack suggestion screen displays the healthiness of the two snacks in the form of stars, and shows the prices of the snacks. Stars are used because our needs assessment revealed that participants did not understand dietary nutritional values (e.g., proteins, carbohydrates). Finally, the user can view a history of the snacks he consumed along with their healthiness, his family's snacking healthiness (Figure 1d), and a convenient shopping list with all the snack suggestions provided by Snack Manager.

Snack Education Prototype: The Snack Education prototype (Figure 2), based on SCT, HBM, and ELM, is designed to educate users about how their snacks affect their health. This prototype provides us with a better understanding of whether the target population is interested in learning about the implications of eating unhealthy snacks. After the user enters a snack from the home screen, shown in Figure 2a, the system displays the snack's impact on the user's heart, body, and teeth. The following screen, shown in Figure 2b, suggests to the user another snack and compares the three health indicators for both the entered snack and the suggested snack. The user can view his overall snack history, snacking details, and family snacking comparison (Figure 2c). The aggregated snack healthiness in the family snack comparison screen is represented by a snack healthiness bar that consists of different colors corresponding to the healthiness of snacks.



(a) Home Screen

(b) Snack Suggestion Figure 2. Snack Education Prototype

(c) Family Snack Comparison

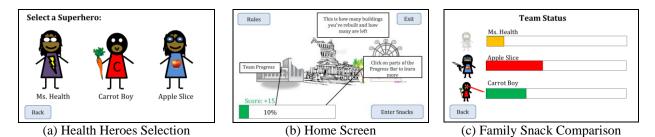


Figure 3. Health Heroes Prototype

Health Heroes Prototype: The Health Heroes prototype, shown in Figure 3, is a gaming application that is based on SCT and HBM. In the game, the user selects a health hero character (Figure 3a), who has to defend the city of Denver against the onslaught of Taco Belly - the main villain. The game starts with Taco Belly causing destruction in Denver, as seen on the home screen in Figure 3b, where ruined buildings need to be rebuilt. The Health Heroes need to gain different superpowers to fight Taco Belly and rebuild the city. These superpowers can be gained by increasing healthy snack points, which in turn are obtained by eating healthy snacks. As the player eats healthy snacks, she can successfully counter Taco Belly's attacks that include adverse events comprised of unhealthy snacks. For example, Taco Belly can turn Denver's water supply into soda or throw huge blocks of butter over the Denver area. The Health Heroes prototype also has a multi-player mode where different family members play the game and coordinate to form a team of Health Heroes to fight Taco Belly. The players can view their individual snacking points breakdown and team status (Figure 3c). Once the city buildings rebuild, the players need to keep eating healthy snacks to counter a surprise attack by Taco Belly.

Lifespan Prototype: The last of the four prototypes - the Lifespan prototype - is a gaming application that is based on SCT and PAPM. The player selects a character whose progress in life is related to the healthiness of player's snacks. The character goes through different stages of life, shown in Figure 4, that include acquiring an education, getting a job, and earning money to buy a house and a car. The idea behind designing these stages is to provide the target population an escape from their low SES through the virtual character of the Lifespan prototype. The game has a scoring criteria based on the healthiness of snacks. Players can move to the next stage when they gain a predetermined amount of points. Once the player reaches the final stage, he has to maintain healthy snacking; otherwise he will fall back to the previous stage.

Methods

After the participants provide informed consent, they will complete a background questionnaire detailing their basic demographic information, technology savviness with computers and mobile phones, and snack preferences. Their technology savviness will assist us in analyzing how they interacted with the prototypes. Snack preferences will assist us in developing a realistic, functional prototype that contains the unhealthy and healthy snacks that prospective participants regularly consume. After the background questionnaire, the participants will be provided with a list of tasks that they will be asked to perform using the four different mobile phone application prototypes. The prototypes will be running on Motorola Droid smart phones and will be presented in a random order.



Congratulations! I graduated from the University because of your healthy eating. Continue eating healthily to get an internship.

(a) Player receives a degree





(c) Player buys a house and a car

(b) Player gets a jobFigure 4. Lifespan Prototype

Participants will be asked to think aloud while performing the tasks on the prototypes. During the usability testing, the facilitator will ask questions to understand which prototypes the participants prefer, reasons for their preference, shortcomings of the prototypes, and ideas to overcome these shortcomings.

Analysis

The videos and the interview data will be analyzed to identify which prototypes the low SES families prefer and why. The videos will be transcribed and coded in NVivo qualitative analysis software to identify the design issues in the prototypes. The qualitative analysis results will be compared with the post-study questionnaire to draw conclusions about the usability and participants' prototype preferences. If substantial usability issues are identified in the study, then the prototypes will be re-designed and re-evaluated in another iteration of this study. If however, the prototypes have minor usability problems, then these will be rectified and the resultant prototype will be used for developing the functional sociotechnological intervention.

Anticipated Outcomes and Contribution to Health Informatics

This research will advance the field of health informatics by providing guidelines for designing a sociotechnological intervention for low SES families to improve their snacking habits. In addition, the research will showcase how families can potentially be engaged to improve their snacking habits.

Future Work

In the near future, we will develop the optimal prototype into a functional prototype and conduct a month-long field trial to evaluate its effectiveness. The field trial will include pre- and post- intervention photo-elicitation interviews where the participants will take pictures of their snacks and discuss these pictures with us. We will also conduct multiple semi-structured interviews during the study period. The study results will inform guidelines for designing a sociotechnological intervention to improve low SES populations' snacking habits.

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