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Refinement and Pilot Testing Social Networks for Encouraging Healthy Behaviors: The Social Pounds Off Digitally (Social POD) Study

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REFINEMENT AND PILOT TESTING SOCIAL NETWORKS FOR ENCOURAGING HEALTHY BEHAVIORS: THE SOCIAL POUNDS OFF DIGITALLY (SOCIAL POD) STUDY

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DEDICATION

My dissertation is dedicated to my Mother, Judy McMahon; my Father, James Bridges, my Stepfather, Jerry McMahon, and my Husband, Kevin Hales - whose love and support has made all of this possible.

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ABSTRACT

Currently about 71% of adults in the US are considered overweight or obese. Overweight and obesity are associated with higher risk of developing many chronic diseases; however, health risks associated with overweight and obesity can be reduced by as little as a 3% to 5% reduction in weight. Mobile health (mHealth) has shown promise as a way to deliver weight loss interventions, yet maintaining participant engagement over time has been a challenge.

The purpose of this study was to develop, refine, and pilot test the Social Pounds Off Digitally (POD) Android app for personalized health monitoring and interaction; revise the Social POD app based on participant feedback; and conduct a multi-site randomized clinical trial to pilot test the second iteration of the Social POD app.

Overweight and obese adults with Android smartphones (BMI 25-49.9 kg/m^2; N=9) were recruited for a two-month weight loss pilot intervention and iterative usability testing of the Social POD app. The app prompted participants via notification to track daily weight, diet, and PA behaviors. Participants received the content of the behavioral weight loss intervention via podcast. In order to re-engage infrequent users, the app prompted frequent app users to select one of three messages to send to infrequent users targeting one of three behavioral theory constructs: 1) social support, 2) self-efficacy, or 3) negative outcome expectations. Body weight and dietary intake (two 24-hr recalls) were assessed at baseline and two months. All participants attended one of two focus groups to provide feedback on use of the app. Based on the usability testing, the Social POD app was refined and a point-based incentive system was incorporated into the app and used in a larger randomized controlled trial. Overweight and obese adults (N=51, mean BMI=34.7 ± 6.0, 38% black) in Charleston and Columbia, SC who owned an Android phone or tablet were recruited to participate in a 12-week behavioral weight loss intervention delivered via mobile app and podcast. All participants received the behavioral content of the weight loss intervention via twice weekly podcasts and were randomized to download and use either a standard calorie tracking app (Fat Secret) or the Social POD app. Main outcomes included kilograms lost at 12-weeks and secondary outcomes included change in psychosocial variable scores from pre- to post-test, association between points earned and percent weight loss at 12-weeks, and re-engagement based on message-type received.

Following the usability testing participants lost a mean of -0.94 kg (±2.22 kg, p=0.24) and consumed significantly fewer kcals post-intervention (1570±508 kcal/day) as compared to baseline (2384±993 kcal/day, p=0.01). Mean number of app entries was 77.2 ± 73.8 per person with a range of 2 to 219. Messages selected and sent to infrequent users targeting social support were sent most frequently (n=32, 46%), followed by self-efficacy (n=29, 40%), and negative outcome expectations (n=10, 14%). Themes from the focus groups included functionality issues, revisions to the messaging system, and the addition of a point system with rewards for achieving goals.

Participant attrition for the RCT was 12% (n=3 experimental and n=3 comparison). Experimental group participants lost significantly more weight (-5.3kg, CI:

-7.5, -3.0) than comparison group participants (-2.23kg, CI: -3.6, -1.0; *p*=0.02) and had a greater reduction in BMI (*p*=0.02). These outcomes were significant for both intention-to-treat (using baseline observation carried forward) and complete case. While there were significant differences in final positive outcome expectations scores between groups [4.56 experimental, 3.57 comparison (scale range from 1 to 7, maximum); *p*=0.04], other secondary outcomes (e.g., caloric intake and social support) were not significantly different by group assignment while controlling for baseline values.

Among experimental group participants only, total points earned significantly predicted percent weight loss (*B*=-0.02, *p*=0.01). In addition, higher scores for the conscientiousness personality trait was significantly associated with total points earned (*B*=9.07, *p*=0.03), but other personality characteristics and demographics were not. Messages most frequently sent to infrequent users of the Social POD app were social support (n=119), followed by outcome expectations (n=99), and then messages targeting self-efficacy (n=97). There was a significant difference between the type of message received and re-engagement among infrequent users (*p*=0.03) with self-efficacy messages prompting the most engagement (n=7), followed by outcome expectation messages (n=5) and social support messages (n=1).

In conclusion, use of the Social POD app led to greater weight loss than a standard diet-tracking app (Fat Secret). This mobile health intervention has the potential to be widely disseminated to reduce the risk of chronic disease associated with overweight and obesity.

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List of Abbreviations

App	Application
ASA24	Automated Self-Administered 24-Hour Dietary Recall
ASPIRE	Advanced Support Program for Innovative Research
BMI	Body Mass Index
DPP	Diabetes Prevention Program
MP3	Portable Media Player
mHealth	Mobile Health
PA	PA
PAR-Q	PA Readiness Questionnaire
POD	Pounds Off Digitally
RCT	Randomized Clinical Trial
S.C.	South Carolina
SCT	Social Cognitive Theory
SCTR	South Carolina Clinical Translational Research Institute
SDT	Self-Determination Theory
SMS	Short Message Service
SLT	Social Learning Theory
TBP	Theory-Based Podcast
U.S.	United States

CHAPTER 1

Introduction

1a. Problem Identification and Definition

Currently over 71% of adults in the US are considered overweight or obese (BMI >25 kg/m^2).[1] Overweight and obesity are associated with type 2 diabetes, hypertension, cardiovascular disease, arthritis, and asthma.[2,3] There is also an increased risk of several cancers[4] such as postmenopausal breast[5] and prostate[6] among those who are overweight or obese. Health risks associated with overweight and obesity can be reduced by as little as a 3% to 5% reduction in weight.[7,8]

Behavioral interventions that target improvements in diet and physical activity (PA) are an effective way to help people lose weight and decrease chronic disease risk factors associated with overweight and obesity.[9] mHealth has shown promise as a way to deliver weight loss interventions and is a more convenient and less time-intensive delivery method than face-to-face individual or group sessions, especially among populations that are hard to reach through traditional intervention delivery.[10] mHealth interventions are intended to provide participants with access to health information and tools for monitoring health behaviors on-the-go, such as via smartphone, versus other internet-based programs that deliver information through a more stationary modality, such as a computer.[11]

Weight loss programs have been developed and delivered via internet and other web-based platforms as well as through social media (e.g., Facebook[12] and Twitter)[13] to promote weight loss and reduce health risks of chronic disease. Participant engagement with social media in the context of these weight loss interventions has been shown to be related to weight loss.[12,13] While there are many benefits of delivering weight loss interventions using remote methodologies, maintaining participant engagement over time as well as providing sufficient social support in these types of interventions is a challenge.[14] Furthermore, there are many free and paid weight loss apps available for both Android and Apple platforms; however researchers have noted that few of the available apps (free and paid) include many of the evidence-based techniques used in weight loss interventions.[15]

1b. Broad Objectives of this Study

The goal of the next phase of research and the purpose of this study is to fill gaps in existing research by integrating behavioral techniques derived from health behavior theory, specifically Social Cognitive Theory (SCT)[16] in the development of a new Android-based smartphone and tablet app. The Social POD app was designed to enhance participant engagement and motivation for engaging in healthy diet and PA behaviors in the context of an entirely mobile-based weight loss intervention. Please see Table 3.3 for a detailed description of components of the Social POD app and Chapter 3 for a detailed description of the intervention methodology and implementation.

1c. Theoretical Framework Guiding the Development of the Social POD app

Initial components of the first iteration of the Social POD app were developed using constructs from SCT to promote participant engagement with the app. The first round of usability testing of the Social POD app was conducted in spring of 2014, followed by refinement and development of features to promote participant motivation and engagement with the app over the summer and fall of 2014, and concluded with a pilot randomized clinical trial (RCT) conducted in spring of 2015. Below is a description of SCT constructs utilized in the Social POD intervention with a concluding section on the link between health behavior theory and the development of specific components of the Social POD app to promote healthy diet and PA behaviors for weight loss.

Social Cognitive Theory

SCT describes the reciprocal interactions between human cognitions, environmental influences, and human behavior.[16–19] SCT is based in part on Social Learning Theory (SLT), which is grounded in the belief that individual behavior is learned by observing and modeling the behavior of others, and therefore, not simply a product of an individual's personal experiences.[16,17,19] SCT expands on the concepts of SLT to incorporate the cognitive (e.g., thoughts and beliefs) and emotional relationships (e.g., expectations) influencing and influenced by the environment (e.g., behavioral role-models).[19]

According to SCT, individual behavior is determined by perceived control, which is the belief that one has the power to control his or her behavior. Furthermore, behavior change typically does not occur unless individuals feel they have the capacity to do so.[19] Specific factors found to be related to positive health behavior change include: goal setting, self-efficacy, and outcome expectancies.[19] Of importance is an individual's sense of self-efficacy, which is the belief or perception that one is able to perform specific behaviors and overcome challenges.[19] When planning behavioral health interventions, it is important that participants set realistic, incremental, and achievable goals leading to positive behavior changes.[19]

Behavioral capability is the degree to which an individual possesses the necessary skills and training to perform specific behaviors (e.g., preparation of low calorie fruits and vegetables to reduce daily caloric intake).[19] Behavioral interventions should be designed to provide individuals with the necessary education and development of specific skills to carryout the desired behaviors. Positive and negative expectations about the outcome of certain behaviors are important considerations for behavior modification interventions. Behavioral interventions should model positive outcomes of targeted behaviors (e.g., positive expectations about dieting, engaging in PA, and self-monitoring behaviors).[19] Finding appropriate models that participants can identify with (e.g., others similar to the target audience who successfully perform desired health-related behaviors) is important when targeting observational learning. Observational learning originated as a construct of SLT and suggests that individuals learn from their own experiences as well as from observing the experiences of others.[19]

The use of reinforcements, which are responses to behavior to increase targeted health behaviors, is a common approach utilized for behavior modification.[19] Positive reinforcements (e.g., providing rewards) tend to increase the probability that a person will repeat a behavior whereas negative reinforcements are the removal of something that leads to increased behavior.[19] SCT suggests that reinforcements are best utilized in this framework when participants self-select their rewards and provide rewards for themselves (i.e., internal reinforcements) rather than receiving rewards from others (i.e., external rewards) to promote long-lasting (versus short-term) behavior change.[19]

Social POD App Components: Link between Health Behavior Theory and App Design

As self-efficacy is a central construct of SCT and is integral in bringing about behavior change by enhancing participants confidence in performing tasks and overcoming barriers,[16,17,20] it was one of the key constructs selected as a target through the user-user messaging system in the Social Pod app. Social support, while not one of the original constructs of SCT, works to enhance an individual's self-efficacy by providing support for performing specific behaviors. It has been found that when participants receive support from others, this support serves to bolster confidence in one's ability to perform tasks and overcome barriers.[17] In addition to social support, SCT suggests that positive outcome expectations are enhanced by increasing a participant's self-efficacy for performing certain behaviors (e.g., reducing caloric intake, engaging in PA, or tracking caloric consumption using a smartphone app) thereby increasing the frequency in which participants perform the targeted behaviors related to weight loss (e.g., dieting, PA, and self-monitoring).[17] These constructs (self-efficacy, social support, and outcome expectations) are the determinants that are targeted through the user-user messaging system to produce desired behavior changes (engagement in dieting, PA, and self-monitoring) among users of the Social POD app.

Podcasts, developed using SCT and tested in several interventions,[13,21,22] were used by participants in this intervention to promote behavioral capability for making healthy diet and PA behavior changes. In addition to the goal setting activity in the podcasts, an incentive system with small and achievable goals related to app usage were developed using principles from SCT and feedback from focus groups during the usability testing of the first iteration of the Social POD app. As part of the usability-testing phase, podcast scripts were revised to reflect technology updates in diet, PA, and weight tracking. Podcast episodes were re-recorded with new actors to improve the sound quality and to include a wider diversity of voices. Participants were able to earn points for achieving goals each day, and participants earned prizes in exchange for their points at the end of the study, targeting positive reinforcements. For a detailed description of results from usability testing of the first iteration of the Social POD app, please see the first manuscript of Chapter 4.

1d. Research Questions and Specific Aims of this Dissertation

This study examined if use of the Social POD app and theory based podcasts (TBP) is more effective for weight loss than using a standard tracking app (Calorie Counter by Fat Secret) and TBP.

Aim 1: Refine our intelligent social agent mobile app (Social POD) based on results from our usability testing (two-months, N=9) and develop new components for use in a three-month pilot RCT.

Aim 2: Conduct a three-month pilot RCT among overweight and obese adults (N=51) comparing a TBP plus self-monitoring using the standard tracking app (TBP + Fat Secret) versus TBP plus self-monitoring with the Social POD (TBP + Social POD) from February to May of 2015.

Hypothesis 2a: Participants in the experimental group (TBP+Social POD) will lose significantly more weight than those in the comparison group (TBP+Fat Secret).

Hypothesis 2b: Participants in the experimental group will have a significantly greater increase in social support, self-efficacy, and outcome expectation scores than those in the comparison group.

Aim 3a: To determine if the number of points earned by participants is associated with percent weight loss at three-months among experimental group participants.

Hypothesis 3a: The number of total points earned will be significantly associated with percent weight loss at three-months such that the more points a participant earns, the more weight they will lose.

Aim 3b: To determine if type of message received (social support, self-efficacy, or outcome expectations) is associated with re-engagement with the Social POD app among infrequent users (infrequent users defined as not entering data in the Social POD app within the past 48-hours).

Hypothesis 3b: Messages targeting social support will be sent most frequently. Messages targeting social support will be significantly associated with re-engagement among infrequent users.

1e. Justification of Research

Rates of overweight and obesity remain high among US adults. There are numerous health risks associated with overweight and obesity; however, these risks can be reduced with just a 3% to 5% reduction in body weight.[7,8] Behavioral interventions are effective at promoting weight loss among adults and have been delivered using remote means including the Internet and smartphones.[10,12,13,22–34] Benefits of electronic and mobile interventions for weight loss include reduced time and cost associated with participation in interventions, increased anonymity, and less risk of potential embarrassment to the participant. While there are many commercial smartphone applications that are available to the public, most of these applications include few of the evidence-based strategies and behavioral theory utilized in traditional behavioral weight loss interventions[13,16,17,20] and most have not been rigorously tested in clinical trials to determine which components impact health behavior and health outcomes.[35] A promising avenue for enhancing the quality of mHealth interventions for public use includes the integration of theory-based content utilizing a SCT[16] framework to increase participant engagement and motivation in the context of a mobile-based weight loss intervention. The purpose of this research is to test the effectiveness of an evidence-based smartphone application (Social POD app) to promote participant engagement and motivation in the context of an entirely mobile-based weight loss intervention among a sample (n=51) of overweight and obese (BMI $\geq 25 - 49.9$ kg/m^2) adults with Android smartphones or tablets in South Carolina (S.C.).

1f. Preview

In the following chapters of this dissertation, a synopsis of the background and significance of this research will be presented along with a content analysis of currently available commercial weight loss apps and a literature review, organized by topic, in Chapter 2. In Chapter 3, a presentation of the methodology used will be presented and organized by Specific Aim. In Chapter 4, three manuscripts reporting outcomes from Specific Aims 1, 2, and 3a will be presented followed by results from Specific Aim 3b. Conclusions, recommendations, and future directions are presented in Chapter 5.

CHAPTER 2

BACKGROUND, SIGNIFICANCE, AND LITERATURE REVIEW

2a. Introduction

This section of the dissertation has been organized according to topic. Chapter 2 begins with a presentation of the prevalence of overweight and obesity in the U.S. and S.C. followed by the physical health and economic costs of these conditions to demonstrate the significance of this public health problem. A discussion of the potential contribution of mHealth interventions to promote weight loss and reduce the burden of overweight and obesity will be presented as a justification for pursuing this line of research to promote healthy diet and PA behaviors among overweight and obese adults in S.C. The background section of this chapter will begin with a presentation of current statistics for smartphone and health app usage followed by a detailed content analysis of current weight loss apps available on the Google Play Store for Android devices. An expert review of commercial weight loss apps will be presented to demonstrate the need to incorporate evidence-based components traditionally delivered in clinical behavioral weight loss interventions to strengthen mHealth interventions. Pilot work for this current line of research will be discussed followed by results from several technology-based interventions for weight loss, and a review of recent literature pertaining to the development and usability testing of mHealth weight loss apps for adults.

Significance of Problem and Background

The Surgeon General has declared overweight and obesity as one of the most burdensome health issues currently affecting Americans today.[36] Rates of obesity and overweight rose over the past 30 years and have recently leveled but remain high.[37] Current national obesity rates show that 34.9% of adults over age 20 are obese (BMI ≥ 30).[37] Rates of obesity are highest among adults of all races between the ages of 40-59 at 39.5%, followed by those age 60 or older at 35.4%, those younger than 20 at 34.9%, and those 20-39 at 30.3%.[37] The highest percentage of overweight and obesity (BMI ≥ 25) is in the age group of adults age 40-59 years at 75.3% meeting BMI criteria, followed by those older than 60 at 71.6%, those younger than 20 at 68.5%, and those ages 20-39 at 60.3%.[37]

Of Non-Hispanic White adults, men of all age ranges up to age 60 have a higher prevalence of overweight and obesity than women, although rates of overweight and obesity among Non-Hispanic White women in all age ranges is above 50%. Non-Hispanic black women between the ages of 40-59 have the highest overall prevalence of overweight and obesity among all races reported with a rate of 85.2% meeting criteria. Among Hispanics, data indicate that 84% of women and 84.7% of men in the age range of 40-59 meet criteria for overweight and obesity.

In S.C., adults over age 18 consist of 76.6% of the total population in 2010 and of this group 66.9% were overweight (BMI ≥ 25) and 31.5% were obese (BMI ≥ 30).[38] Only 23.3% of S.C. adults reported eating the recommended two servings of fruit per day and only 22.9% reported consuming the recommended three servings of vegetables per day.[39] S.C. adults reported they are not meeting recommendations for PA with less than half engaging in 150 minutes of vigorous activity or 300 minutes of moderate-intensity PA and 26.2% reported not engaging in any type of PA within the specified 30 day timeframe.[40] National and local data reveal that interventions are necessary to increase consumption of healthy foods (fruits and vegetables), increase PA, and aid in the reduction of overweight and obesity among adults to reduce the incidence of chronic and preventable diseases.

Adverse consequences of overweight and obesity

Costs of overweight and obesity are many and include detrimental health outcomes, increased cost of health care, potential or partial disability, as well as social stigma.[36] The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity suggests interventions targeting environmental and behavioral factors contributing to overweight and obesity allow the greatest opportunity for prevention and treatment.[36] According to the Surgeon General obesity is associated with an increased risk of numerous health conditions and diseases including: type 2 diabetes, heart disease, stroke, hypertension, gallbladder disease, sleep apnea, asthma, certain cancers, high blood cholesterol, complications of pregnancy, menstrual irregularities, depression, and social stigma.[36]

Indirect costs of obesity across the U.S. are many and include lost wages due to inability to work or disability and lost wages due to premature death.[36] According to the S.C. Obesity Burden Report of 2011, it is estimated that $1.2 billion dollars was spent due to health conditions associated with obesity and it is projected to increase to $5.3 billion dollars by 2018.[41] It is projected that the state will have to spend the equivalent of $1,505 per adult due to the economic burden of health conditions associated with obesity;

however, if the rate of obesity could remain the same, it would save the state an estimated $858 per adult, which is equal to a total of $3 billion in savings.[41] Nationally individuals with a BMI greater than 30 spend more in medical costs than their peers with a BMI less than 25.[42] In S.C. about 10% of Medicare expenditures and about 16% of Medicaid expenditures are related to obesity.[43]

Bridging gaps and advancing science in obesity research

While there are programs designed to address the high prevalence of overweight and obesity, there remains a need for better weight loss interventions given the continued high rates of overweight and obesity among adults in the U.S. and S.C.[37] mHealth presents exciting new opportunities to engage large numbers of individuals in weight loss interventions that are more convenient, less costly, and require less effort to disseminate than traditional face-to-face or group behavioral weight loss programs.[15] While there are Internet-based interventions and commercial smartphone apps available, most have not been developed by experts in health promotion using evidence-based strategies and sound behavioral theories.[15,44,45] In addition most currently available smartphone apps have not been rigorously tested to assess efficacy and weight loss outcomes among overweight and obese users.[15] The Social POD smartphone app bridges this gap between commercially available weight loss apps and evidence-based interventions for weight loss and can be disseminated to a wider audience for the Android platform through the Google Play Store.

Current Statistics of Technology Use

Current Pew Reports indicate that most adults in the U.S. own cell phones (about 85%) and of those who own cell phones 64% own smartphones.[46,47] Most smartphone owners are of Hispanic (49%) ethnicity followed by African Americans (42%) and Caucasians (42%).[44] The Android platform is the most commonly used representing 28% of all cell phone users, iPhone at 25%, and Blackberry at only 4%, according to the most recent Pew statistics.[46]

U.S. adults are using their phones to access health information and advice. Of smartphone owners, over half (52%) use their phones to access health information, with college educated Hispanic and African Americans between the ages of 18-49 comprising the demographic group with the highest rate of accessing health information via smartphone.[44] About 19% of smartphone owners are also using their phones to download and use health apps. The most popular types of apps used among smartphone owners include those to aid with PA (38%) and diet tracking (31%), followed by weight management (12%).[44] Less frequently used apps include those designed for tracking menstrual cycle, blood pressure, pregnancy, blood sugar (diabetes), medication management, mood, sleep, and other types of health-related activities.[44] Despite the widespread availability and use of apps to track weight loss and other health-related behaviors, few commercially available apps for weight loss include many of the evidence-based strategies included in traditional behavioral weight loss interventions; furthermore, these apps have not been rigorously tested to determine their impact on health behavior.[15,35,45]

The following sections provide an overview of the apps available for weight loss on the Google Play store, and an overview of relevant research studies utilizing technology-based approaches for weight loss intervention delivery.

2c. Content Analysis of Available Weight Loss Apps

A content analysis of current weight loss apps available for the Android platform was conducted on September 11, 2014 and updated on February 25, 2015. The author identified popular weight loss apps first using the "search" menu on the Google Play store accessible via web browser and using the search term "weight loss." The second search was conducted using an Android tablet and searching from the category menu on the Google Play store app. The "health and fitness" section was selected, and then the "weight loss apps" button was selected resulting in a list of eight apps in September of 2014. The apps listed as weight loss apps in the Google Play store in September of 2014 included: Weight Watchers, My diet coach, Water your body, Sleep as Android, Couch to 5k, Daily yoga, Nexercise, and All the Cooks Recipes. From this menu, there was the option to select a button to "see more" weight loss apps, and selecting this button resulted in a total of 16 apps, including the eight previous apps displayed and eight others. Results included the following additional apps: Calorie Counter with My Fitness Pal, Noom Weight Loss, Jamie's 20 Minute Lifestyles, Calorie Counter by Fat Secret, Noom Cardio Trainer, Fast Food Calorie, Lose it, and 7 Minute Workout. In February of 2015, additional apps (other than the ones listed above) displayed on the "weight loss apps" page of the Google Play store included: Chef Tap App, Runtastic Push-ups, Runtastic Sit-ups, and Runtastic Squats.

Please see Table 2.1 for results from the content analysis of apps identified as "weight loss apps" from the Google Play store in both September of 2014 and February of 2015. The content of these weight loss apps was examined by downloading each of the free apps to an Android tablet and examining all free features and making note of which features (if any) required a fee. Please see Table 2.1 for a description of the basic statistics for each app.

Table 2.1: Basic Statistics of Available Weight Loss Apps from the Google Play Store

App Name	Fees	Stars [1]	Number of downloads	Other
My diet coach	$3.99 upgrade with calorie counter	4.3	1 million	Integration with Android wear. Enter your starting weight.
Water your body	$5.99 per app per feature added	4.4	1 million	None
Sleep as Android	$4.49	4.5	500 thousand	None
Daily yoga	None	4.1	1 million	Shows poses and has music – guided yoga app.
Nexercise	None	4.4	500 thousand	Leaderboard among friends
All the cooks recipes	None	4.3	10 million	Appears to not be related to weight loss.
My Fitness Pal	None	4.7	10 million	Can track steps now and can connect to other apps (like Digfit).
Noom Weight Loss Coach	$9.99/month for upgrade	4.3 Editors choice [2]	10 million	Set weight loss plan (calorie limits) based on profile. Listed as Editor's Choice.
Noom Cardio Trainer	Up-grade available for $9.99	4.3	5 million	Sync with music
Jamie's 20 minute meals	$7.69	4.3	100 thousand	Appears to not be related to weight loss.
Calorie Counter by Fat Secret	None	4.3	10 million	Recipes and meal ideas. Comprehensive and easy to use database of brands and restaurants. Can customize color scheme on app.
Lose it!	Upgrade goals for $39.99/ year	4.5	1 million	Customizing calories by age, gender, height, and weight. Can have a passcode. Save frequent food and exercises for tracking.

7 minute workout	Pay $1.99 to remove ads.	4.3	500 thousand	This is an app that takes you through a 7-minute work out (step by step, with pictures, and time count.
Fast Food Calorie Lookup	None	4.3	100 thousand	Appears to be more of a calorie database of items from popular restaurants.
Couch to 5K by RunDouble	Free trial. Upgrade for $1.60	4.7	1 million	Integrate with My Fitness Pal for additional features included in MFP app.
Runtastic Pedometer	1.99 for pro version without ads.	4.3	100,000	Integration with MyFitnessPal. Provide calories expended (enter weight and height for accuracy).
Runtastic Squats Trainer	$1.99 upgrade to Pro to eliminate ads and get access to more badges for completing challenges.	4.5	1 million	Upload workout to Runtastic app. Personal feedback from a "coach." Integrate with MyFitnessPal.
Runtastic Sit-ups	$1.99 upgrade to Pro to eliminate ads and get access to more badges for completing challenges.	4.3	1 million	Upload workout to Runtastic app. Personal feedback from a "coach." Integrate with MyFitnessPal.
Runtastic Push-ups	$1.99 upgrade to Pro to eliminate ads and get access to more badges for completing challenges.	4.5	1 million	Upload workout to Runtastic app. Personal feedback from a "coach." Integrate with MyFitnessPal.
ChefTap Recipe App	None	4.4	100,000	Not related to weight loss. App for cataloging recipes.

[1] User rating system. Minimum of 0 and maximum of 5 star ratings possible. [2] A distinction given by Google Play Store editors to recognize apps determined to be among the top apps available on the Google Play Store.[48]

Weight loss apps from the Google Play Store reviewed for this analysis typically included several features such a newsfeed, barcode scanner, weight graph, notifications/reminders, and journals. A newsfeed displaying status updates from others allows users to communicate with each other to provide support, share barriers to weight loss, and communicate about other topics as well as view and encourage each other's progress with weight loss-related goals. For ease of tracking calories consumed, some apps have the ability to use the device camera to scan the barcode of packaged foods. Some apps also include a graph of users' body weight as entered in the app, enabling users to view their weight over time. Prompts to track various behaviors related to weight loss (e.g., self-monitoring caloric intake, body weight, etc.) are also included in some of the apps as notifications or reminders. Having the ability to make notes or create a journal with topics related to achieving weight loss goals are also included in some apps. Please see Table 2.2 for a list of features included in each of the apps from this content analysis.

Table 2.2: Table of Features Included in Weight Loss Apps Available from the Google Play Store

App Name	**Newsfeed**	**Barcode Scanner**	**Weight Graph**	**Notifications & reminders**	**Notes Page**
My diet coach	None	None	None	Yes	None
Water your body	None	None	Yes	Yes	None
Sleep as Android	None	None	None	At bedtime & wakeup.	None
Daily yoga	None	None	None	None	None
Nexercise	Yes	None	Yes	None	None
All the cooks recipes	None	None	None	None	None
My Fitness Pal	Among friends. Can "like" their news.	Yes	Yes	Only if have not logged anything for 1, 3 or 7 days. Also for meals/snacks.	Food and PA separate.

Noom Weight Loss Coach	None	None	Yes	Meals only. Sends emails about re-engaging with app.	None
Noom Cardio Trainer	None	None	None	PA, weight, distance/calories.	None
Jamie's 20 minute meals	None	None	None	None	None
Calorie Counter by Fat Secret	None	Yes	Yes	Every other week email reminders with forum info.	Yes
Lose it!	With friends.	None	None	Meals and end of day tracking.	You can comment on your history.
7 minute workout	None	None	None	Set reminders to work out.	None
Fast Food Calorie Lookup	None	None	None	None	None
Couch to 5K by RunDouble	None	None	None	Reminders during your run for pace and halfway mark.	None
Runtastic Pedometer	None	None	None	None	None
Runtastic Squats Trainer	None	None	None	None	None
Runtastic Sit-ups	None	None	None	None	None
Runtastic Push-ups	None	None	None	None	None
ChefTap Recipe App	None	None	None	None	None

Very few apps (15%) reviewed for this content analysis included some type of newsfeed or in-app feature allowing users to communicate with each other publicly and post information available for all users to view related to their weight loss. Two apps included a barcode scanner for ease of tracking calories consumed from packaged foods. Some apps (25%) included a graph showing body weight entered in the app over time allowing users to adjust their eating and exercise behaviors to promote weight loss. A little less than half of the apps reviewed (40%) included some type of reminder to track behaviors with only 30% having reminders related to tracking diet, PA, or body weight. Very few apps (15%) included notes or journaling features but one app (MyFitnessPal) included a unique journal feature allowing users to make note of relevant information pertaining to their diet and PA behaviors separately.

The author used constructs from health behavior theories including SCT[16,19,20] to evaluate the inclusion of evidence-based components of behavioral interventions included in the available weight loss apps from the Google Play store. Of the apps analyzed for this review, only 38% (My Diet Coach, Nexercise, My Fitness Pal, Noom Weight Loss Coach, Fat Secret, and Lose It) included some of the evidence-based components known to be effective for weight loss and included in traditional behavioral weight loss interventions including: self-monitoring of diet, activity, and weight (i.e., tracking features), social support through social media or messaging features, and incentives or goals for achieving weight loss or weight-loss related goals in line with health behavioral theories. Please see Table 2.3 for a list of behavioral weight loss features included in each of the apps from the content analysis.

Table 2.3: Table of Behavioral Weight Loss Features Included by App

App Name	Tracking	Messages	Social Network	Weight Loss knowledge	Goals	Incentives
My diet coach	Self-monitor weight.	None	Facebook and Twitter.	None	Select reasons for wanting to lose weight. Select challenges such as drink water, park far away, and fill half of plate with veggies.	Points to dress your avatar.
Water your body	Self-monitor weight and	None	Can share with others	None	None	None

	water consumption .		via email.			
Sleep as Android	The app tracks your sleep by placing the phone/tablet by your pillow and setting a wake alarm.	None	Twitter	None	None	None
Daily yoga	The app tracks completion of yoga sessions completed but only with FB login.	Only through Facebook	Facebook	None	None	None
Nexercise	Self-monitor weight and PA only. Track PA as you do it or track a previous work out. Earn points for activity to earn rewards.	Chat with others based on topics or find friends via contacts, Facebook, Twitter, text or email.	Facebook and Twitter	None	None	Earn points toward gift cards at national chain stores, CVS, Walmart, Best Buy, or prizes like FitBit.
All the cooks recipes	No self-monitoring features.	None	None	None	None	None
My Fitness Pal	Calorie, PA and weight self-monitoring. Quick add calories, recipes, save frequent food and create food items. Multiple items can be entered at one time.	Email messages and ability to send between friends. Receive an email when you get a message.	Link with Facebook.	None	Goals for weight and calorie limit (also set macro and micro nutrients). Fitness goals for duration, calories expended, and frequency per week.	None
Noom Weight Loss Coach	Self-monitor weight, PA, and food consumed.	Gives pre-set encourage ment when you enter a	Only with paid upgrade.	Limited. Receive information with paid upgrade.	Set a weight goal.	None

		weight.				
Noom Cardio Trainer	Self-monitor PA only.	None	Facebook and Twitter	None	Race against yourself with feedback during PA.	None
Jamie's 20 minute meals	No self-monitoring features.	None	None	None	None	None
Calorie Counter by Fat Secret	Self-monitoring of calories, PA, and weight.	None	None	None	Reports progress toward weight goal.	None
Lose it!	Self-monitoring of calories, weight, and PA.	None	Invite friends via email.	Provides a calorie budget.	Goal weight. Join challenges. Join support groups. Customize goals for $39.99/year with upgrade.	Get badges for various things (logging weight loss). This is emailed to you.
7 minute workout	App tracks when 7-minute workout is completed. No other self-monitoring features.	None	Share by email and Google +	PA knowledge regarding benefits of this type of PA.	None	None
Fast Food Calorie Lookup	No self-monitoring features.	None	None	None	None	None
Couch to 5K by RunDouble	Track running progress only with GPS tracking feature. Integration with My Fitness Pal for other features. No other self-monitoring features.	None	None	None	None	None

Runtastic Pedometer	Records all steps and calculates speed during activity. No other self-monitoring features.	None	Share activities on Google+, Facebook and Twitter.	None	Can complete 10,000 steps challenge.	None
Runtastic Squats Trainer	Tracks completed squat repetitions by holding the device while squats are performed. No other self-monitoring features.	Monthly or yearly reports	Share activities on Google+, Facebook and Twitter. Also via email.	None	None	Earn badges for performance. Leaderboard.
Runtastic Sit-ups	Tracks completed sit-ups for you by placing phone/tablet on your chest. No other self-monitoring features.	Monthly or yearly reports	Share activities on Google+, Facebook and Twitter. Also via email.	None	None	Earn badges for performance. Leaderboard.
Runtastic Push-ups	Tracks push-ups completed by placing phone/tablet on floor near your face. No other self-monitoring features.	Monthly or yearly reports	Share activities on Google+, Facebook and Twitter. Also via email.	None	None	Earn badges for performance. Leaderboard.
ChefTap Recipe App	No self-monitoring features.	None	Import recipes to/from Pinterest	None	None	None

Many of the apps examined in the previous content analysis focused on one component of weight loss such as diet only, PA only, or neither. Only 20% of the apps featured as weight loss apps in the Goolge Play store included self-monitoring of both diet and PA behaviors along with daily self-monitoring of weight (four of the 20 total apps listed in Table 2.3), including Lose it!, My Fitness Pal, Calorie Counter by Fat Secret, and Noom Weight Loss Coach. It is worth noting that Noom Weight Loss Coach was the only app listed as a weight loss app in Google Play Store that received the Editor's Choice distinction for high quality, popularity, and ease of use; however, this rater found the Noom app very difficult and very cumbersome to enter food consumed, minutes of PA completed, and body weight as compared to the other apps that include self-monitoring features. Despite the proliferation of apps marketed as weight loss apps, very few of the ones examined in this analysis from the Google Play Store contained behavioral weight loss techniques included in most behavioral weight loss interventions.

Other key findings from an expert review of commercial weight loss apps

In 2013, Pagoto and colleagues conducted an extensive review of the top apps for weight loss for both the Apple and Android platforms and included both paid and free apps.[15] Pagoto and colleagues used the Diabetes Prevention Program (DPP) components as a framework for identifying behavioral characteristics included in the reviewed apps. Key components of lifestyle behavioral interventions according to the DPP include: weight loss goal, dietary goal, calorie balance, PA goal, exercise safety, benefits of healthy diet and PA, food substitutions, food pyramid, stimulus control, portion control, lifestyle activity, target heart rate, problem solving, stress reduction, relapse prevention, negative thinking, social cues, developing a regular pattern of eating, time management, and nutrition label reading. While developers of commercially available smartphone apps are continuously updated to incorporate new features (e.g., self-monitoring, social networks for support, and goals for weight loss), some key components identified by the

DPP are not incorporated. The authors concluded that of the 29 apps that were reviewed, only 65% of the key components identified by the DPP were included in these apps. The app that included the highest percentage of evidence-based components was My Net Diary and My Net Diary Pro (the paid version of the same app), which at the time of publication of this article was only available for the Apple platform.[15] Since publication of this article, My Net Diary Pro is available (with in-app purchases) for the Android platform as of February 14, 2015. From the Pagoto et al analysis, the Android app with the highest percentage of evidence-based components included was Noom Weight Loss (also included in the previous content analysis by this author of currently available apps for weight loss on the Google Play store) with only 25% of the evidence-based strategies for weight loss included. Findings from the review conducted by Pagoto and colleagues and the previous content analysis of apps for weight loss conducted for this dissertation indicate a need for researchers and experts in health promotion and behavior to work with app developers to incorporate key components known to be effective in producing long lasting healthy behavior change and weight loss.

While the Social POD app contains many of the same key components included in other Android apps (i.e., self-monitoring of diet, PA, and weight; reminders for self-monitoring; incentives, goals, social networks), the goal of the Social POD app is to enhance engagement among infrequent app users and provide external motivation for app usage among participants in the experimental group of this weight loss intervention. The weight loss intervention used in this study included multiple components such as: 1) behavioral weight loss skills training delivered via podcast (both groups), 2) diet tracking using a standard app (Fat Secret for comparison group) or the Social POD app (experimental group), and 3) additional engagement and motivational features of the Social POD app (experimental group only) tied to self-monitoring of behaviors and providing encouragement to other users. It is hypothesized that increased engagement among infrequent users combined with external motivation and reinforcement to participants for use of the Social POD app will result in significantly greater weight loss among experimental group participants as compared to comparison group participants using the tracking features of the Fat Secret app.

2d. Pilot Work for Current line of Research

Through a grant funded by the South Carolina Clinical and Translational Research Institute (SCTR), an interdisciplinary team of faculty, graduate, and undergraduate students from the Computer Science, Health Promotion, Education, and Behavior, and Exercise Science Departments at the University of South Carolina developed the Social POD app for the Android platform in the fall semester of 2013. Features of the first iteration of the Social POD app included: 1) tracking features for entering calories consumed by meal (breakfast, lunch, dinner, and snacks), as well as minutes of PA completed and weight each day; 2) daily prompting features to remind participants to track diet, PA, and weight using the Social POD app; 3) a user-user messaging system prompting frequent users (used app within past 48-hours) to send messages (developed using SCT) to infrequent users (have not used app within past 48-hours) to prompt re-engagement with the app, 4) weight graph to chart changes in weight over time; and 5) a history page to view data entered in the Social POD app.

In the spring of 2014, usability testing was conducted with nine members of the community to test and refine the components developed in the original version of the

Social POD app as well as gain participant insight into the types of incentive systems to integrate into the app. Proposed revisions and the addition of an incentive system for the app were based on feedback from focus group participants during our usability testing. The next phase and the purpose of this dissertation research proposal was funded by the USC Advanced Support for Innovative Research Excellence (ASPIRE) grant and included the refinement of features and the development and testing of an incentive system (multiple components listed below) to promote participant motivation and engagement with the smartphone app and weight loss intervention. Revisions of existing features of the Social POD app and the addition of several components for the second iteration of the app was based in-part on the following literature review and included input from participants provided during focus groups from our usability testing study conducted in spring of 2014. Additional components developed during the summer and fall of 2014 included: 1) a database with calorie content of commonly consumed foods and beverages to improve diet tracking features; 2) notes screen for participants to track emotions or activities related to weight loss; 3) goal screen to list participant goals tied to use of the Social POD app; 4) point tracker to chart individual points earned in exchange for prizes for achieving goals; 5) newsfeed to provide updates on participant goal achievement with opportunities to send encouragement to other participants, and 6) aesthetic revisions.

2e. Review of Technology-based Weight Loss Interventions

This section provides a description of several studies that formed the basis for the Social POD intervention. In a study that helped inform the user-user messaging system of the Social POD app, Anderson-Bill and colleagues[17] examined the theoretical constructs underlying behavior change in an online intervention for weight loss. In this article, the authors described the impact of SCT constructs (self-efficacy, social support, self-regulation, and outcome expectations) for engaging in PA and self-monitoring behaviors using structural equation analysis. Also of interest was how these constructs impacted weight loss at 16-months among a group of 272 adults.

The Anderson-Bill et al. study revealed that participant weight loss at 16-months was predicted by PA, consumption of fruits and vegetables, and caloric intake. At six-months, improvements in PA self-efficacy, PA self-regulation, nutrition support, and nutrition outcome expectations contributed to weight loss. Participants with increased social support, self-efficacy, and self-regulation also had improved levels of PA. The authors concluded that the online program influenced behavior and weight loss as expected using these constructs, and that improving participant's self-efficacy, social support, self-regulation, and outcome expectations in varying combinations led to healthier diet and PA behaviors resulting in weight loss.[17] During the study, participants most interested in online interventions experienced higher initial levels of self-efficacy but authors concluded that even participants with lower interest in online interventions may still receive intended benefits.

Social support, self-efficacy, and outcome expectations were chosen as determinants of weight loss behaviors in the Social POD app based on findings from Anderson-Bill et al., as results from this study demonstrated significant changes in diet and PA behaviors which resulted in weight loss among a sample of overweight and obese adults.[17] This intervention was delivered via Internet, and the Social POD study is seeking to provide similar improvements in self-efficacy, social support, and outcome expectations regarding diet and PA behaviors resulting in weight loss using a mobile intervention accessible via smartphone and tablet app.

Others sought to examine ways to effectively engage participants in a weight loss intervention delivered via mobile technology with additional social support provided via Twitter.[22] The type of social support (delivered via messages posted to Twitter) was examined as well as whether posting to Twitter was correlated with weight loss among study participants enrolled in a six-month weight loss intervention. Results indicated that the number of Twitter posts was significantly correlated with percent weight loss at six-months. Participants reporting initial weight loss predicted engagement with Twitter. Prior use and initial engagement with Twitter did not predict later engagement with Twitter. The most frequent type of support provided among participants using Twitter was informational (teaching sub-type) and took the form of a status update. Other types of support used were: suggestions/advice, listening, and complements. The least utilized type of support was tangible assistance such as direct tasks, indirect tasks, or active participation. This study served as a basis for the initial messages developed for the Social POD app for the user-user messaging system to target social support. Providing supportive messages via smartphone and tablet app with the integration of other behavioral weight loss features has the potential to shape how future behavioral weight loss interventions are delivered.

Online discussion forums have also been examined as a way to provide support for those attempting to lose weight. Hwang and colleagues[33] studied the types of supportive messages posted by participants using an Internet-based weight loss community. A mixed-methods model with surveys and interviews was utilized as well as a content analysis of the discussion forum messages to examine the types of social support provided by the participants of this forum. Results from this study indicated that about half of the participants read forum messages, 36% responded to messages, and 18.5% posted messages to the forum to start a discussion. Major themes that emerged from forum discussions were motivation and encouragement (mentioned at least once by 86%), followed by information (58.5%), and shared experiences (42.5%). For the revision of messages designed for the user-user messaging system in the second iteration of the Social POD app, it was important to include statements that were motivational, encouraging, and include shared experiences to gain the attention of study participants and increase engagement among infrequent users. Participants from our usability testing also noted that they would prefer messages that are more encouraging than the messages previously developed and used during usability testing.

Sub-themes of messages posted from the Hwang et al. study[33] included testimonies, recognizing others for success, accountability, friendly competition, and humor. Because it is important to recognize successes of others, the additional feature of a newsfeed was developed and integrated into the second iteration of the Social POD app to allow participants to provide encouragement to others for their success (e.g., sending a "star" to participants who consistently track their diet, PA, and weight or those who have logged at least 30 minutes of PA). The newsfeed in the Social POD app was linked to the incentive system, such that when a participant sent a "star" to another participant for achieving a goal, they earned an additional point. The newsfeed component of the Social POD app was developed because participants in the usability test reported they would like to see how others are doing during the intervention and send encouragement in a form other than the user-user messages, which only targeted infrequent users.

Participants in the Hwang et al. study also reported they valued anonymity, convenience, and non-judgmental interactions of the message forum experience.[33] To help ensure anonymity is retained, participants were identified within the Social POD app via study ID only. While some participants in the usability test reported wanting an option to compose messages for the messaging system, the use of pre-written and theoretically driven messages continued to be used to test which type(s) of messages (self-efficacy, social support, or outcome expectations) best re-engage infrequent users with the Social POD app. Authors from the Hwang study concluded that social support played a valuable role in weight loss efforts and that further study is warranted to improve how social support is used to augment weight loss in future interventions.[33]

In examining the most effective and cost effective mHealth method of prompting participants to self-monitor their behaviors and send messages to infrequent users, various methods were examined including Short Message Service (SMS), also called text messaging. SMS interventions have recently been developed and implemented internationally and in the U.S. to address overweight and obesity. Text messages are short messages (up to 160 characters) that are sent from one mobile device to another.[49] Text messaging is prevalent among cell phone users with 75% indicating use of SMS in a recent Pew Research Report.[50] In a recent study, Steinberg and colleagues conducted a remotely delivered intervention combining goal-directed texts related to self-monitoring and tips for weight loss among treatment group participants (n=26) compared to an equivalent control group (n=24).[51] Results indicated that while participants reported the texts were helpful, there was no significant weight loss found among treatment groups post-intervention (six-months) as compared to baseline measures of body weight. In addition the authors did not find a significant relationship between texting and percent weight lost.[51]

While significant weight loss was not achieved in the previous study utilizing a text messaging intervention, others have found significant weight loss with this mode of delivery as compared to control groups.[49] In a literature review of text message-based interventions for weight loss, Shaw and Bosworth found that within the past four years, eleven of 14 studies using text message-based interventions found significant weight loss outcomes.[49] In addition, this type of intervention delivery was concluded to be feasible as text messaging can be automated and is less costly than traditional weight loss programs. However, this review conducted by Shaw and Bosworth found that monetary costs of these interventions were typically not reported in manuscripts.[49] Because there are monetary costs associated with sending and receiving texts, these types of remotely delivered interventions are potentially more costly for those who are implementing and participating in them than using other modalities, such as podcasting and smartphone apps. To reduce the burden of added costs on participants and study implementers, the Social POD app relied on in-app messaging and prompts delivered through existing smartphone and tablet notifications rather than text messages.

Podcasts, which are audio files that are downloaded from the Internet to an MP3 player, smartphone, or computer present another platform to remotely deliver weight loss interventions.[13,21,22] In one of the first studies of its kind, Turner-McGrievy and colleagues[21] developed weight loss podcasts designed using SCT. Authors compared the enhanced podcasts to commercially available podcasts for weight loss among a group of 78 overweight and obese adults in the southeastern U.S. Results indicated that participants using the enhanced podcasts lost more weight and had a greater reduction in BMI than control group participants at the end of the 12-week RCT. In addition, treatment group participants reported greater weight loss knowledge as a result of using the enhanced podcasts compared to the control group.[21] The podcasts that were used in these interventions (Specific Aims 1, 2, and 3) were those developed and tested by Turner-McGrievy and colleagues. Podcasts were updated between usability testing and the RCT to improve sound quality and to reflect changes in technology (e.g., using apps to determine calorie content of foods versus calorie books) as part of the SCTR study but all other content delivered via podcast remained the same.

In a subsequent six-month mobile intervention, Turner-McGrievy and colleagues combined the enhanced podcasts from the previous study with a mobile app for diet and PA tracking (My Fitness Pal) and Twitter for social support for the enhanced group (Mobile group) compared to a podcast only group (Control group) (n=96).[22] Results from this study indicated that there were no significant differences in weight loss between the two groups. There were significant differences in how participants tracked their diets with the Mobile group using the mobile app and the Control group participants using a Web-based program or a paper and pencil approach to diet tracking. In addition Mobile participants downloaded more podcasts than Control group participants, and results indicated that downloading podcasts was correlated with weight loss among both groups.[22]

Authors concluded that this study demonstrated that evidence-based intervention can be successfully implemented via Podcast but that prompting mobile communication (Twitter and My Fitness Pal) without any feedback did not enhance weight loss among participants.[22] A strength of this study was that it utilized a completely mobile-based intervention delivery, as in the Social POD studies, and used existing technology (Twitter and My Fitness Pal) to enhance weight loss outcomes. A limitation of this study was the lack of Twitter use among participants to enhance social support. Authors concluded that further research is needed to enhance engagement with mHealth interventions to promote social support in the context of mobile-based weight loss interventions.[22]

Engaging participants in the context of remotely-delivered interventions has been a challenge in the emerging field of mHealth and continues to be at the forefront of research in this area.[14] The development of the Social POD app with a user-user messaging system to provide support to participants is the result of years of research on the part of this team. The next phase of research, and the focus of Specific Aims 1, 2, and 3, entailed further refining of the Social POD app to enhance engagement, motivation, and support for participants.

In an effort to incorporate features to help motivate participants to use the self-monitoring and messaging features of the Social POD app, both tailored and pre-set goals tied to rewards were considered to enhance participant motivation. In a review article conducted by Teixeira and colleagues examining motivational interviewing, Self-Determination Theory (SDT), and weight loss, authors concluded that when participants were internally motivated to lose weight such as engaging in dieting behaviors for their intrinsic (e.g., for fun or enjoyment) versus extrinsic (e.g., attractiveness, fit societal expectations regarding appearance, or reduce discrimination) value they were more likely to continue to engage in weight loss behaviors long-term and autonomously.[52] Integrating components that target intrinsic motivators for engaging in weight loss behaviors could be used to bolster participant motivation and maintain participant engagement in the context of future mHealth weight loss interventions. The use of tailored goals to promote intrinsic motivation (versus extrinsic) would be beneficial to promote long lasting behavior change, but was not feasible given the time and budget constraints for the development of the second iteration of the Social POD app. Future iterations of the Social POD app should examine the feasibility and acceptability of allowing users to tailor their own goals to better enhance intrinsic motivation for engaging in behaviors to promote weight loss. Changes in participant motivation were measured in this current line of research to better help inform future iterations of the Social POD app.

Review of Literature with Specific Emphasis on the Development and Usability Testing of mHealth Apps for Weight Loss and Weight Maintenance among Adults

While there has been much work in the area of mobile app development for health, there is currently little published research in the area of development and testing of new mobile apps for weight loss among overweight and obese adults. There are several recent studies documenting the development and testing of new apps for weight loss in adolescents,[53] apps for increasing PA and reducing screen time among adolescent males,[54] and apps for predicting risk of childhood obesity among infants.[55] Several recent studies report on the development and testing of apps for behavior modification of diet and PA among the adult and young adult population and these three studies will be discussed below. [56–58]

Similar to the usability testing conducted for the Social POD app, Morrison and colleagues utilized a mixed-methods design for the usability testing of their smartphone app in conjunction with a weight management intervention website among 13 healthy adults recruited from a university over a one-month time period.[56] Objective data regarding app use was collected and phone interviews were used to collect qualitative data regarding the use of and suggestions for improvements to the POWeR app. The app component of this intervention included the following components: ability to set and view healthy eating and PA goals, personal reasons for losing weight, a list of low-calorie food items, and tracking features to keep track and monitor progress toward attaining personalized goals. The app also featured notifications, which could be modified by participants, to remind them to self-monitor their goals. If participants completed daily goal updates, they received personalized feedback. Use of this weight maintenance intervention resulted in a significant increase in participants' reported awareness of eating habits (p=0.05) and achievement of eating goals (p=0.03) but not for PA goals (p=0.10). Objective data revealed that the app was typically used in small increments of time with an average of three minutes of app use (± two minutes). Participants were given the option to discontinue the notifications to self-monitor daily goal achievement, and as a result, only 54% of participants elected to receive these notifications. The participants that used the notifications (5 total) reported the notifications helped them keep their goals in mind and remember to self-monitor progress toward goal achievement. Participants responded to notifications 52% of the time notifications were received, and the range of time to respond to a notification was seven seconds to four hours. Authors reported that notifications were only received by participants intermittently during the duration of the four-week study. Participants reported they felt the app was more convenient for accessing information while mobile. Participants also reported that having access to their goals while mobile increased their motivation for achieving behavioral goals. Participants suggested that the notifications provide more personalized feedback when reminding participants to self-monitor their goal-achievement progress.[56] Over the course of the study, participants did not use the self-monitoring tools to monitor goal-achievement. When asked why the goal tracking features were underutilized, participants cited that updating their goal-progress took too much effort and a lack of personalized feedback contributed to underutilization of this feature.[56]

Consistent with feedback from participants in the usability test of the first iteration of the Social POD app, participants from the Morrison et al study[56] reported that it was too time consuming to set personalized goals and therefore this features was underutilized. One participant in the Social POD usability test also noted that some individuals might set goals that are unachievable. While SDT suggests that tailored goals are best for promoting intrinsic motivation and therefore better for achieving long term behavior change, more thought will have to be given to determine if and how mHealth interventions should provide this type of support to participants in the future.

Researchers have sought to better understand user preferences to enhance engagement with weight loss apps over time. Tang and colleagues conducted a qualitative study using structured interviews with 19 young adult community members following brief use (three-weeks) of several commercially available weight loss apps.[57] The authors sought to determine what components promoted motivation to use the app, if apps could increase user motivation to lose weight, which characteristics of the apps enhanced user satisfaction, and what components of these apps helped to promote weight loss among users. Participants were instructed to use their favorite weight loss app or one of the following: My Fitness Pal, Livestrong, Calorie Counter, or Spark People. Participants agreed that the apps used increased their motivation to lose weight by focusing on goals. For example, one participant mentioned her goal of eating within a recommended calorie limit to promote weight loss was motivational. Another participant recommendation to increase motivation was to have the app acknowledge when goals are achieved, such as sending some type of encouragement when a calorie goal was met. It was important to participants that the apps be very user friendly and easy to set-up, versus requiring many complicated steps during set-up. The perceived attractiveness of the app was very important to all participants in this study. Having a visually appealing interface and using pictures was recommended to improve engagement and satisfaction with the apps. Including options for tailoring based on personal characteristics such as height and weight were recommended. One participant reported wanting tailored feedback such as advice regarding how best to eat at restaurants and drink alcohol while on a diet. App components reported by participants to result in weight loss and maintenance included: an extensive food database with a range of foods and brands of foods, food scanner for ease of tracking dietary information from packaged products, notifications and reminders to self-monitor eating behaviors, a diary to record factors that affect eating and exercise behaviors, and social support. The social support components provided by message boards/forums and through social media sites (Facebook and Twitter) received mixed reviews by participants. One participant noted s/he was unaware their information was made publically available on a social networking site and another participant reported that being afraid of public scrutiny served as a motivator to eat well. Another participant reported feeling very skeptical and distrustful of information posted on social media and on message forums associated with their app, given that some posts could be promotions for products/services and some individuals giving advice lack the necessary qualifications to provide this type of information. On the other hand, one participant reported that seeing others had logged PA encouraged her to engage in PA. Change processes identified as resulting in weight loss included: promoting goal achievement related to weight loss (e.g., meeting diet, activity, and weight goals) to make participants more self-aware of behaviors that need to be modified, self-monitoring behaviors to increase awareness and allow users to evaluate their behaviors in relation to their goals, providing positive feedback regarding self-monitoring, providing achievements and rewards to promote behaviors, and providing some type of social support. Opinions regarding the various methods used to provide social support via apps seemed to be mixed. Some participants preferred sharing details regarding their weight loss goals whereas others preferred not having to share details of their weight loss in order to receive support.[57]

Feedback from participants in the usability test of the first iteration of the Social POD app was consistent with participant feedback in the Tang et al. study,[57] such as providing an attractive user interface, acknowledging when goals are achieved, and integrating a database for ease of self-monitoring calories consumed. All of these features were integrated into the second iteration of the Social POD app based on participant feedback and consistent with feedback from other studies, such as the Tang et al. study. Additional comments from participants in the Tang et al. study included the use of pictures to enhance the attractiveness of the user interface, including a bar-code scanner, providing tailored calorie goals, and receiving feedback from qualified others. In an effort to provide support and re-engage infrequent users, the second iteration of the Social POD app included the opportunity for participants to send each other encouragement for achieving goals (via "stars") as well as the user-user messages targeting SCT constructs. Use of pre-written messages in the Social POD app reduced the potential for adverse consequences resulting from user-generated messages or messages written by others and posted on message boards.

In the final study reviewed, Hebden and colleagues[58] authored a paper describing the process of developing and testing the usability of four web-based apps designed to modify behaviors associated with weight gain among 21 young adults including: consumption of fruits and vegetables, engaging in PA, consumption of fast food, and consumption of sugar-sweetened beverages. Each of the apps required participants to enter a four-digit login for confidentiality purposes and university technology students were used to develop the web-based apps. Ten of the 21 adults recruited used the four apps and a small sub sample of these adults provided qualitative feedback using a study-provided survey designed to elicit feedback regarding problems experienced and suggestions for improvements. The apps took a total of 18 months to develop and the overall cost of development was $20,000 (about $5,000 per app), which authors noted is about half the development cost of most commercial apps. Developers chose to use a web-based platform, meaning that the app was accessed through the Internet browser of the smartphone. The authors reported the decision to utilize a web-based app was made because web-based apps can be used by any smartphone and tablet with an Internet connection. The use of web-based apps prohibits connectivity with device hardware, such as having the ability to integrate the use of a smartphone camera for barcode scanning or sending notifications through a device notification system; however, the developers decided this connectivity was not needed for these apps. Some of the participants noted on their surveys that they were dissatisfied with having to login to the apps with their four-digit code and that the apps ran very slow on their devices. Participants also reported the apps crashed and that the scrolling features were not operating (one participant noted they could not enter fruit and vegetable information because the screen would not scroll). Only one suggestion was provided to improve the apps, and this participant suggested the developers integrate rewards that participants could earn for performing desired behaviors.[58]

Consistent with some of the functionality issues reported by participants in the usability test of the Social POD app, similar issues such as app crashing were reported by participants in the Hebden et al. study. Although Hebden et al. did not receive many suggestions for improvements to their apps, the one recommendation for an improvement was to include rewards for performing desired behaviors. The recommendation to provide rewards is consistent with recommendations from participants in the usability test of the Social POD app.

2f. Summary of Current Status of Problem

Support for the current approach include confirmation by Anderson-Bill and colleagues that in a previous Internet-based study, targeting social support, self-efficacy, and outcome expectations led to improvements in diet and PA behaviors which resulted in significant weight loss among participants.[17] Past studies have also demonstrated that mobile-based interventions are effective for weight loss.[13,17,21,49] Studies reviewed in this document also captured extensive qualitative feedback from participants to improve satisfaction, engagement, and motivation to improve the quality of weight loss apps.[33,57,58] Other studies have also utilized iterative usability testing to improve the quality of their apps, as was conducted with the Social POD app.[56,58]

Future directions for mHealth weight loss research should focus on addressing the lack of evidence-based strategies included in many of the apps designed and promoted for weight loss. Furthermore, experts are calling for the rigorous testing of weight loss apps as many of the commercially available apps have not been rigorously tested to determine their impact, if any, on health outcomes.[15,35] While interventions implemented via text message are less burdensome on developers and interventionists, this method of intervention delivery could pose added economic burden on participants and implementers due to the cost of sending and receiving text messages. While Turner-McGrievy and colleagues found that a behavioral weight loss program can be delivered through remote means (podcast + My Fitness Pal + Twitter), there was a lack of Twitter use among participants.[22] This finding suggests the need to develop methods to provide social support in the context of behavioral weight loss mHealth interventions in the future.[22]

This research will address the gaps identified in the literature by including behavioral techniques used in weight loss interventions such as self-monitoring of behaviors, behavioral goals to achieve, and incentives for achieving behavioral goals. Participants were also able to monitor the progress of others on a newsfeed, provide others encouragement for achieving behavioral goals, and send/receive theory-based messages in an anonymous and non-threatening manner to promote engagement of infrequent users with the Social POD app. To reduce the potential burden of cost, notifications were sent to participants via device notification centers to remind participants to self-monitor behaviors and send/receive encouragement and messages from others without requiring a texting plan. To provide social support in this entirely mobile-based intervention, theory-based messages were sent from frequent users to infrequent users to help re-engage infrequent users with the Social POD app.

2g. Aims and Hypotheses

The overall goal of this research is to test the effectiveness of an enhanced, evidence-based, smartphone app for weight loss based on SCT compared to a commercially available smartphone app among a sample (n=51) of overweight and obese (BMI $\geq 25 - 49.9$ kg/m^2) adults with Android smartphones and tablets in S.C.

Specific Aims of this research included first refining the Social POD app based on results from the usability testing (two-months, N=9) and development of new components (e.g., incentive system) for use in a three-month pilot RCT. Specific Aim 2 is to conduct a three-month pilot RCT among overweight and obese adults (N=51) comparing a TBP plus self-monitoring using a standard tracking app (Fat Secret app) versus TBP plus self-monitoring with the Social POD app from February 16, 2015 to May 8, 2015. Specific Aim 3a is to determine if the number of points earned by experimental group participants (Social POD app) is associated with percent weight loss at three-months. Specific Aim 3b is to determine if type of message received (social support, self-efficacy, or outcome expectations) is associated with re-engagement with the Social POD app among infrequent users (infrequent users defined as not entering data in the Social POD app within the past 48-hours).

2h. Conceptual Framework of the Second Iteration of the Social POD app used in Aims 2 and 3

The conceptual framework of the Social POD app is based on a similar internet-based weight loss intervention conducted by Anderson-Bill and colleagues utilizing a SCT framework.[17] Results from the Anderson-Bill et al. study found that improving self-efficacy and social support for engaging in healthy behaviors and increasing positive outcome expectations produced change in diet and PA behaviors that resulted in significant weight loss outcomes among study participants.[17]

A previous mobile-based weight loss study demonstrated that engaging in self-monitoring behaviors is one of the key predictors of successful weight loss and weight maintenance; [59] therefore, increasing self-monitoring of weight, diet, and PA was targeted through the Social POD app notification system. To prompt participant self-monitoring participants were instructed during meetings, and encouraged via pre-written notifications sent by the social network server, to use the Social POD app to enter the following information every day: 1) the total number of calories from all meals, snacks, and beverages consumed; 2) total number of minutes of intentional PA completed, and 3) current body weight (in pounds). Messages developed by the interventionists targeted one of three SCT behavioral constructs (social support, self-efficacy, and outcome expectations) which were selected and sent from frequent users (those who used the Social POD app within the past 48-hours) to infrequent users (those who have not used the Social POD app in the past 48-hours) to promote infrequent participant re-engagement. New components were integrated into the Social POD app following usability testing (Specific Aim 1) including: 1) an incentive system (i.e., point system) developed to target extrinsic motivation and positive reinforcements to increase self-monitoring and enhance participant engagement with the app, and 2) goals related to desired health behaviors (dieting and engaging in PA) were developed and integrated into the second iteration of the app to promote engagement and motivation.

Through the use of the Social Pod app it is hypothesized that participants in the experimental group will lose significantly more weight at 12-weeks than comparison group participants (main outcome). It is also hypothesized that psychosocial construct scores will significantly increase from pre- to post-test (significant increase in self-efficacy, social support, and positive outcome expectations), there will be a significantly association between total points earned and weight loss at 12-weeks for experimental group participants, and social support messages will significantly promote re-engagement of infrequent Social POD app users. Please see Figure 2.1 for the conceptual model of the Social POD app.

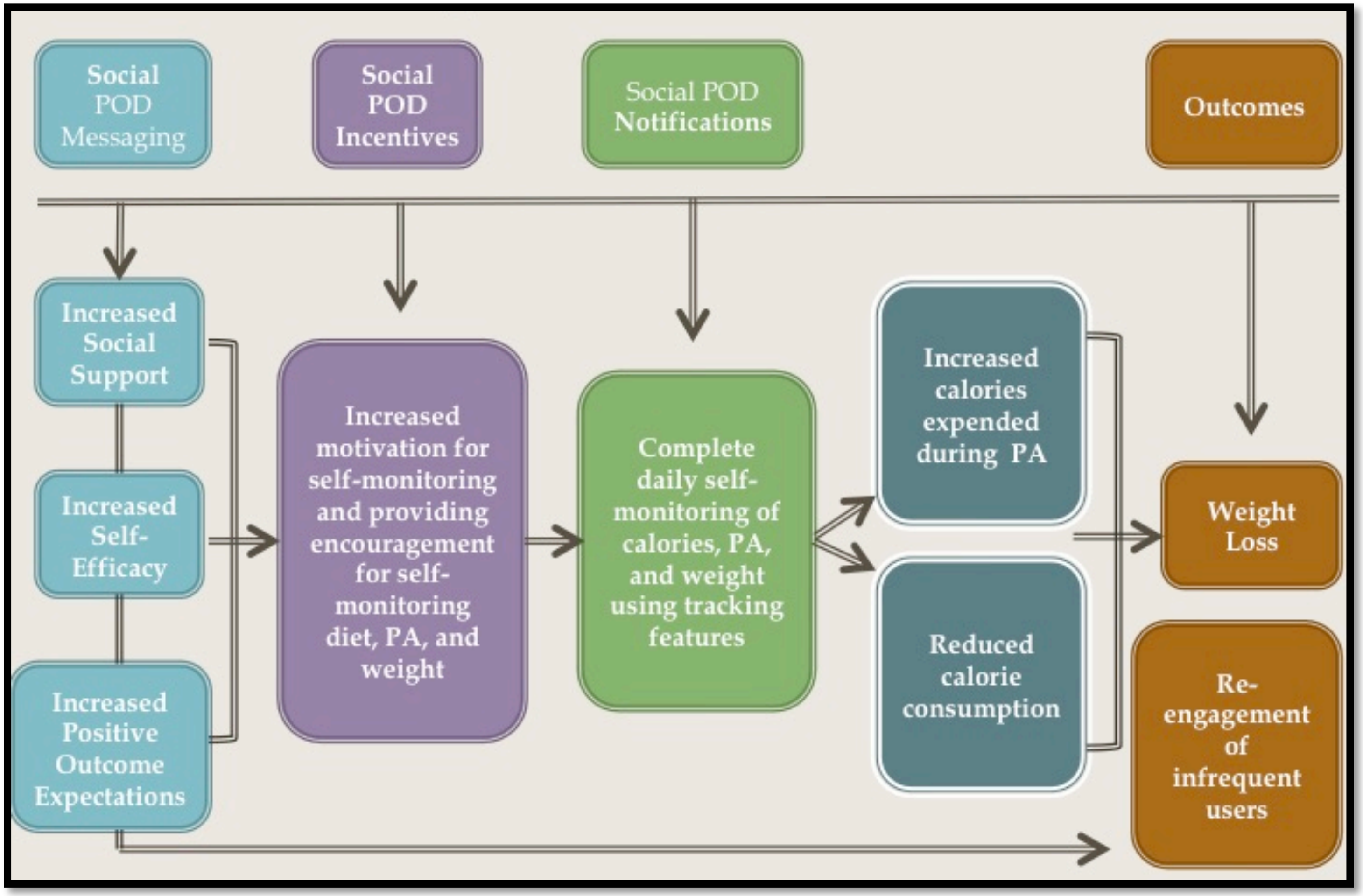

Figure 2.1 Conceptual model of the second iteration of the Social POD app

CHAPTER 3

METHODOLOGY

This chapter is organized according to specific aim with Specific Aim 1 separate from Specific Aims 2 and 3 (as these were separate studies) and provides a description of the study setting, study population, recruitment and retention procedures, description of the intervention, participant randomization process, intervention implementation protocol, a list of study measures collected at various time points, data collection and management protocol, data analysis, process evaluation, and timeline.

3a. Specific Aim 1 Methodology

Participant Recruitment

Overweight and obese men and women with Android smartphones (BMI 25-49.9 kg/ m^2; N=9) were recruited in S.C. for a two-month weight loss pilot intervention to test the usability and provide feedback to be used in the refinement of the Social POD smartphone app. Participants were recruited via worksite listserv announcements at the University of South Carolina and the Department of Health and Environmental Control, university and community flyers, and newspaper advertisements in the State Newspaper.

Exclusion criteria included not having an Android phone, previous stroke or heart attack diagnosis, diagnosis of diabetes and using insulin or oral medications to control diabetes, BMI outside the range of 25.0-49.9 kg/m^2, unable to attend required meetings, unable to access a computer or internet for completing assessments, having a psychiatric illness, receiving treatment for drug or alcohol dependency, having an eating disorder, participating in another weight loss program, being pregnant or planning on becoming pregnant during the study, or breastfeeding. Participants were excluded for endorsing items one through four on the revised PAR-Q[60,61] including: being told by a doctor that they have a heart condition and should only participate in PA approved by a doctor, feeling chest pain when engaging in PA, experiencing chest pain in the past month when not engaging in PA, and ever losing their balance and becoming dizzy or ever losing consciousness. If participants reported a bone or joint problem that could be made worse by participating in PA (item five of the PAR-Q) or taking blood pressure medication (item six of the PAR-Q) they were required to have a physician consent form completed to participate in the study. Participants received a total of $30 for completion of assessments at baseline, one-month focus group ($15), and two-month weight check ($15).

Intervention Implementation

Participants attended a total of four in-person meetings, which included: an orientation session to learn about the study and complete baseline dietary assessments; a training session to learn how to download and use the Social POD app and podcasts and to collect baseline height and weight measurements; a mid-study focus-group at one-month to provide feedback regarding the usability of the Social POD app, provide suggestions for improvement, and complete one-month weight measurements; and an end-of-study session to provide two-month weight measurements. All participants provided written consent. This study was approved by the University of South Carolina institutional review board.

Participants tracked their total calories from all meals, snacks, and beverages consumed (diet); minutes of intentional PA; and body weight each day for the duration of the two-month usability study. Participants were instructed to use MyFitnessPal or LoseIt, which are free commercial diet tracking apps with extensive nutrient databases, to look-up calorie information for food and beverages consumed. Participants were asked to then transfer total calories from each meal and snack consumed for the day to the Social POD app. Screenshots of the tracking features are shown in Figure 3.1.

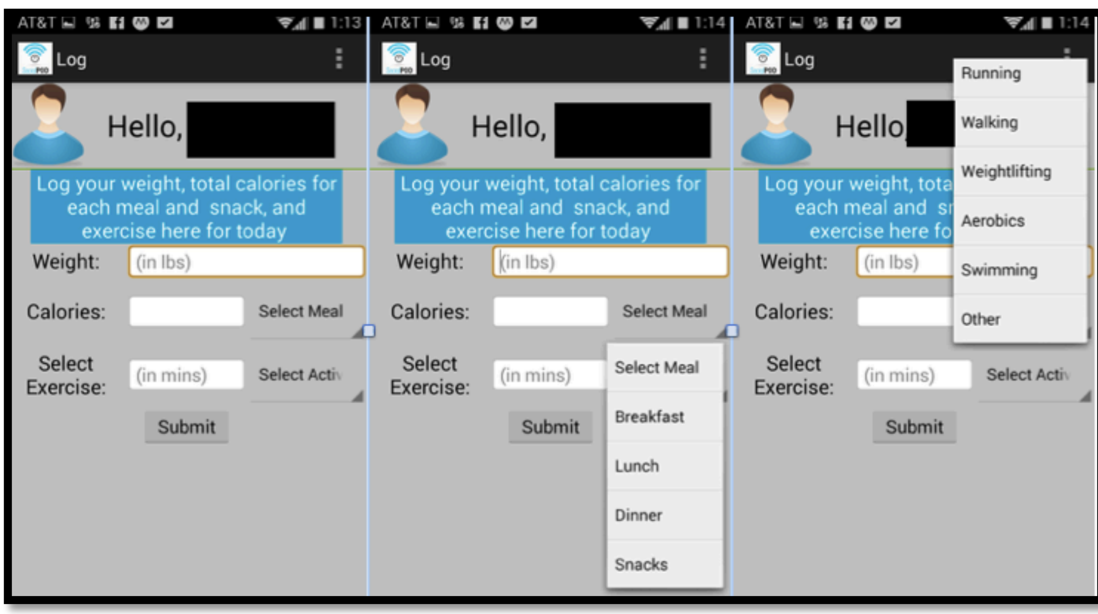

Figure 3.1: Screenshots of Social POD app home, meal tracking, and physical activity tracking screens.

Participants received within-app notifications at certain times throughout the day to remind them to self-monitor (promoting self-regulation) diet, minutes of PA, and total body weight each day. Participants could view a list of all dietary, activity, and weight information entered on the history screen. Participants could view weight entered on a weight graph. Participants who were regularly using the Social POD app (called frequent users and defined as those participants who entered data in the app in the previous 48-hours) were prompted, via notifications, to send encouraging messages to other group members who did not enter data in the app over the previous 48-hours (called infrequent users). Messages were sent from frequent users by clicking the notification to send a message to an infrequent user, selecting one of the messages from the three options listed on the message selection screen, and clicking "send."

This mobile study utilized theory-based messages designed by the interventionists to help re-engage infrequent users over the course of the two-month intervention. Frequent users were randomly matched to provide support (by sending a theory-based message) to help re-engage infrequent users, based on the use of recommender systems utilized by some websites (e.g., Amazon and Netflix).[62–65] Please see Figure 3.2 for screenshots of the messaging system. SCT was used as a framework to design user-to-user messages that targeted social support, self-efficacy, and outcome expectations of performing and self-monitoring (i.e., targeting self-regulation)[66] diet and PA behaviors, and body weight.[13,16,17,20] SCT is the belief in the reciprocal relationship between cognitions, environmental influences, and behavior.[16,18,19] Constructs from SCT were selected for this study based on results from a previous internet-based weight loss intervention, which found that targeting these specific constructs led to healthier diet and PA behaviors and resulting in a reduction of body weight among study participants.[17]

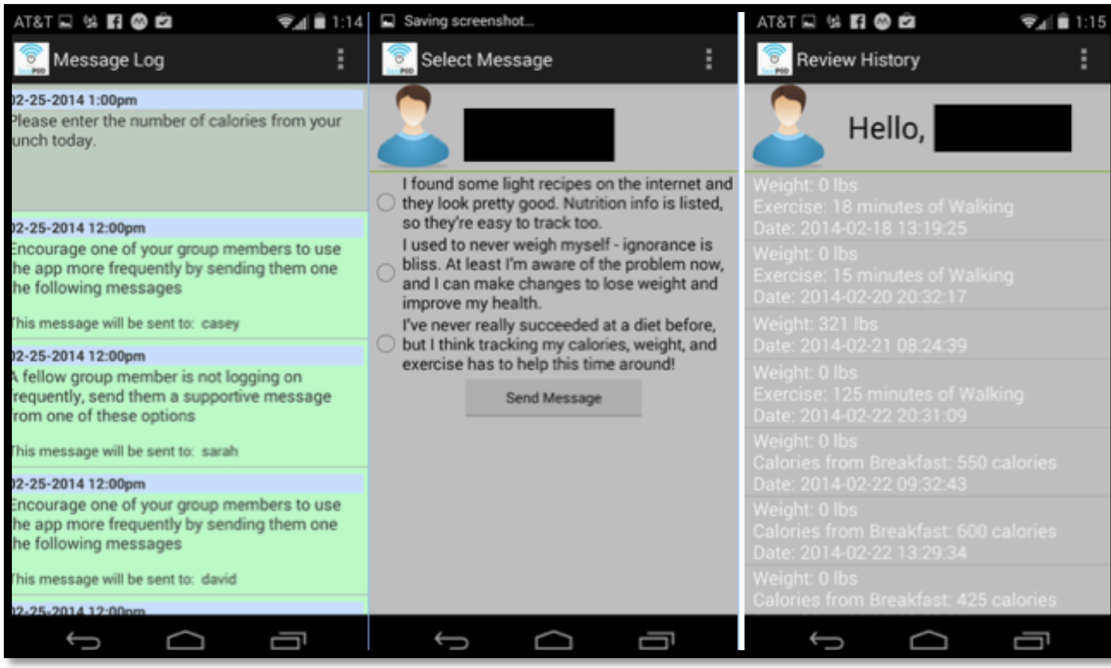

Figure 3.2: Screenshots of the message log, message selection, and history screen of Social POD app.

Table 3.1 provides examples of each message-type as well as the SCT construct targeted.

Table 3.1: User-to-User Message Types by Social Cognitive Theory Construct Targeted

SCT Theory Construct Targeted	**Construct Definition**	**Sample Message**
Self-Efficacy	One's belief in their ability to perform specific tasks and overcome barriers.	"I found some light recipes on the internet and they look pretty good. Nutrition info is listed, so they're easy to track too."
Social Support	Support from others, which can take many forms including information, suggestions, or advice.	"Haven't seen you log anything in the app lately. We miss you!"
Outcome Expectations	Expected outcomes of behaviors.	"I've never really succeeded at a diet before, but I think tracking my calories, weight, and exercise has to help this time around!"

Participants were provided with three, 20-minute, evidence-based weight loss podcasts each week. Podcasts were uploaded by a graduate research assistant to the study website and participants were sent a reminder that a new podcast was available every Monday, Wednesday, and Friday via email. Participants were instructed to listen to three podcasts per week but could listen to the podcasts at a time and place of their choosing. Podcasts were informed by SCT and provided participants with a range of weight loss topics. Podcast topics included: nutrition and exercise information; an audio diary tracking the weight loss progress and challenges experienced by a male and female character; a weight loss soap opera depicting the challenges of overcoming social barriers to weight loss; and a goal setting activity related to weight loss at the end of each episode. Specific information regarding the development and testing of these podcasts in previous interventions can be found elsewhere.[21,22]

Outcome Measures

Participants completed online questionnaires assessing demographic characteristics. Measures of height (SECA 213, using a calibrated stadiometer; baseline assessment only) and weight (SECA 869, Hamburg, Germany, calibrated digital scale accurate to 0.01 kg) were measured at baseline and two-months. Dietary measures were completed by participants using the National Cancer Institute's ASA24.[67] Each participant completed the ASA24 online for one unannounced weekday and weekend day at baseline and two-months. The following previously validated questionnaires were completed by participants at baseline and two-months, unless otherwise specified: the Paffenbarger PA Questionnaire to determine calories expended during activity,[68] the 20-item Weight Efficacy-Lifestyle Questionnaire to measure participant self-efficacy,[69] the

44-item Big Five Inventory (baseline only) as a measure of personality characteristics,[70] the Sallis Social Support Scale[71] and the PA Social Influence Scale as measures of social support from family, friends, and online social networks (modified to include online social networks).[72] Objective measures of frequency and duration of app use was collected unobtrusively by a secure network server following the intervention (at two-months). All baseline measurements were collected prior to the administration of the weight loss intervention.

Participants attended one of two focus group sessions at one-month to provide feedback regarding their use of the intervention components (Social POD app and podcasts). The focus groups were conducted by a trained focus group facilitator and questions were asked using a semi-structured interview guide developed by the investigators, including both pre-scripted and spontaneous probes designed to elicit information from participants regarding their experience with the Social POD app. Questions were designed to assess participant satisfaction and dissatisfaction with the weight loss podcasts, the Social POD app including the tracking, prompting, and messaging features as well as the weight graph and history features for future revisions. Participants were also asked if they would like incentives for using the app, and if so, how they would like an incentive system to be structured. Information regarding aesthetics and appearance of the app was solicited as well.

Focus group sessions were taped using an audio recorder and all participants were instructed to use their study identification number to protect confidentiality during the focus groups. A trained graduate research assistant was present at the focus group sessions to take field notes during the sessions. The focus group facilitator completed detailed memos following each mid-study focus group session to document salient themes from participant discussions. Recordings from the one-month focus group were transcribed verbatim by the trained graduate research assistant and were cross-referenced with recordings for accuracy.

During the study (weeks one through seven) participants completed brief weekly online surveys each Friday to report number of podcasts listened to and number of days they used the Social POD app during the past week (past seven days). Participants also reported if they experienced problems using the Social POD app during the past seven days and if they had suggestions to improve the Social POD app. If participants reported problems or suggestions for the Social POD app, they were then asked to write a detailed response.

Statistical Analysis

All qualitative data were collected and analyzed between February and August of 2014 using NVivo for Mac Beta statistical software (QSR International, 2014) to extract salient themes from the focus groups. Open-ended responses from weekly surveys regarding problems experienced and suggestions for improvements to the Social POD app were coded as well. Stata version 13.1 (StataCorp, 2013) was used to detect statistical significance for all quantitative data analysis. Paired samples t-test was used to test for statistically significant differences from pre- to post-test for weight, calories consumed, and calories expended during reported PA. Effect size for weight loss outcomes, using Cohen's *d*, was calculated for the main outcome of weight loss. Correlation between total days of objectively measured app use and total days of self-reported app use (via weekly questionnaires) by participants was examined. Due to the small sample size, Fisher's exact test was used to detect significant differences in user-to-user message selection among participants categorized into subgroups based on weight loss (high versus low weight loss dichotomized at the median split of percent weight loss). The sample size for this study was determined for qualitative analysis based on expert recommendations for mHealth usability testing studies,[73,74] therefore this study was not powered to detect significant changes in within-group weight; however, changes in weight and weight-related behaviors are presented. For results from these analyses, please see results section of manuscript one in Chapter 4.

3b. Specific Aims 2 and 3 Methodology

The design of this study is a pilot RCT with pre- and post-test weight and psychosocial measures collected from both the experimental and comparison group participants. The experimental group participants received the podcasts and the Social POD app. The comparison group participants received the podcasts and the Fat Secret app for the duration of the three-month study starting on February 16, 2015 and running through May 8, 2015.

Target Population, Study Subjects, and Setting Description

The sample that was targeted for this study was overweight and obese adults (BMI ≥ 25.0-49.9 kg/m^2) between the ages of 18-65 with Android smartphones or tablets. Exclusion criteria included not having an Android phone or tablet, currently taking prescription medication for hypertension, uncontrolled thyroid condition, BMI outside the range of 25.0-49.9 kg/m^2, not having access to a scale, being unable to attend required meetings, being unable to access a computer or internet for completing assessments, having a psychiatric illness, receiving treatment for drug or alcohol dependency, having an eating disorder, participating in another weight loss program, losing more than ten-pounds in the previous six-months, having a member of the same household also participating in this study, being pregnant or planning on becoming pregnant during the study, or breastfeeding.

Fifty-one overweight and obese adult Android smartphone or tablet owners (BMI 25-49.9 kg/m^2; age 18-65) were recruited to participate in a three-month pilot of this weight loss intervention. Detecting differences in weight between the two groups was the primary research goal. It was hypothesized that participants in the experimental group (TBP+Social Pod) would have greater weight loss at three-months than comparison group participants (TBP+Fat Secret). Sample size determination for this RCT was based on mean percent weight loss and standard deviation at three-months from a study utilizing the same podcasts and commercial diet and fitness tracking app (Fat Secret).[22]

Recruitment Procedures Utilized

In an effort to recruit the intended sample the following recruitment strategies were utilized (Table 3.2).

Table 3.2: Recruitment Strategies Implemented in the Social POD Study for Aims 2 and 3

Date	**Location**	**Method of Recruitment Used**
October 14, 2014	Charleston	MUSC Research Expo handouts distributed
October 28, 2014	Columbia	Posted to Dr. Turner-McGrievy's twitter account
November 5, 2014	Charleston	Flyers posted at the College of Charleston
November 6, 2014	Charleston	Announcement posted to Eat Smart Move More Charleston Facebook account
November 6, 2014	Charleston	Handouts distributed to MUSC's Boeing Center for Children's Wellness and Consumer's Choice Health Plan

November 7, 2014	Columbia	USC Times Email
November 7, 2014	Columbia	Listserv announcement circulated to DHEC employees
November 10, 2014	Charleston	Listserv announcement circulated to DHEC employees
November 10, 2014	Columbia	Recruitment announcement published in an article in the State newspaper. Accessible in both print and online.
November 10, 2014	Columbia	Listserv announcement circulated to Richland County Eat Smart Move More
November 11, 2014	Columbia	Flyers posted in public health buildings at USC (Discovery and PHRC buildings).
November 12, 2014	Charleston	Sarah Hales posted announcement to Twitter
November 13, 2014	Charleston and Columbia	Announcement posted to announcements section of Craig's List
November 14, 2014	Charleston	Sarah Hales posted announcement to Twitter
November 17, 2014	Columbia	Flyers posted at Cayce Public Library, Earthfare, and Rosewood Market
November 18, 2014	Columbia	USC Times Email
December 1, 2014	Charleston	Newspaper advertisement in print and online in the Post and Courier on December 1, 3, and 5th.
December 7, 2014	Columbia	Newspaper advertisement in the State newspaper in print and online.
December 15, 2014	Charleston and Columbia	500 postcards sent to households in Charleston and 500 sent to households in Columbia.
December 15, 2014	Columbia	Recruitment announcement posted in the Campus Wellness newsletter running from December 15th through December 17, 2014.
December 19, 2014	Charleston	Announcement posted in the MUSC SCTR e-Newsletter
December 20, 2014	Charleston	Flyers posted in Earthfare grocery store, the West Ashley library, and Starbucks community boards.
December 29, 2014	Charleston and Columbia	Announcement posted to Craig's List announcements page
December 31, 2014	Columbia	Flyers posted at Starbucks, Panera, Whole Foods, GNC, and Cool Beans
January 2, 2014	Columbia	Recruitment announcement circulated via HPEB list serve.
January 5, 2015	Charleston	Listserv announcement posted on the intranet at the Citadel Military College.
January 7, 2014	Columbia	Newspaper advertisement in print and online in the State newspaper.

Setting

The setting for this research was the city of Columbia in Richland County, S.C. as well as the city of Charleston in Charleston County, S.C. In order to participate in this proposed research, participants did not have to be residents of Columbia, Richland County, Charleston, or Charleston County but they had to be willing to attend three face-to-face meetings at the University of South Carolina in Columbia or in Charleston at The Citadel on the assigned dates and times and therefore should reside in Richland/Charleston or a neighboring county or be willing to travel to attend all required meetings.

The total population of Richland County in 2013 was estimated to be 399, 256 persons[75] and the total population of the city of Columbia is estimated to be 133, 358 persons.[76] The ethnic composition of residents in Columbia is a majority Caucasian at 52%, followed by 42% African American, 4% Hispanic or Latino, and 2% a mix of two races.[76] Most recent statistics from the Department of Health and Environmental Control report 25% of the adult population in Richland County is considered obese, 59% are not meeting recommendations for PA, and 83% are not meeting recommendations for fruit and vegetable consumption.[77]

The total population of Charleston County in 2013 was estimated to be about 372, 803 people and the population of the city of Charleston in 2014 was estimated to be 130, 113 people.[78] The ethnic composition of residents in Charleston County is mostly Caucasian at 67%, 29% African American, 5.2% Hispanic or Latino, 1.6% Asian, 1.5% two or more races, 1% Native Hawaiian, and 0.4% of residents identify as American Indian.[78] Most recent statistics from Charleston County indicated that 20% of adults are obese, 48% are not meeting guidelines for PA, and 81% are not meeting recommendations for fruit and vegetable consumption.[38]

Description of Intervention

A detailed list of all intervention components is provided below in Table 3.3 followed by an in-depth description of major intervention components.

Table 3.3: Description of App Components for Social POD and Fat Secret apps

Intervention Component	**Fat Secret app – Comparison Group**	**Social POD app-Experimental Group**
Calculate calorie consumption based on age, gender, height, activity level, current weight, and weight loss goals.	x	
Comprehensive database for looking up calorie content of individual food items and menu items from popular restaurants	x	x
Set a goal weight	x	
Add social network friends	x	
Customizable settings	x	
Help screen		x
Pre-set goals for self-monitoring behaviors		x
Customize profile	x (color scheme)	
Newsfeed to provide reinforcement, encouragement, and updates from others		x
Notes or journal feature	x	x
Weight graph	x	x
In-app prompts as reminders to self-monitor diet, PA, and weight each day	x	x
User-user messages targeting social support, self-efficacy, and outcome expectations for self-monitoring diet, PA, and weight.		x
Incentives for self-monitoring diet, PA, and weight and sending encouragement to others.		x

Evidence-Based Podcasts

Evidence-based podcasts were developed using SCT and tested in several interventions[13,21,22] prior to this proposed research and were utilized by both the experimental and comparison group participants in this intervention. The podcasts covered a range of topics for weight loss including diet and nutrition education (counseling from a Registered Dietitian regarding goal setting activities, nutrition and PA education, and a grocery store tour), a weight loss diary (chronicles the progress of two individuals involved in a weight loss program), a weight loss soap opera (depicts the challenges of overcoming social barriers to achieving weight loss), and a goal setting activity for each episode (e.g. making one meal of the day vegetarian). Podcasts for Specific Aims 2 and 3 were identical to podcasts used in Specific Aim 1, with the exception that they were re-recorded using new actors, improvements were made to the sound quality, and changes were made in the scripts to reflect updates in technology used for self-monitoring (e.g., using an app to determine calorie content of food versus a calorie book).

Fat Secret app detailed description

The Fat Secret app, which is a commercial and free app for diet tracking and is grouped among the weight loss apps on the Google Play store, was used by comparison group participants to track diet, weight, and PA behaviors over the course of the study. Participants in the experimental group were advised to use the calorie database from the Fat Secret app to assist in determining the caloric content of commonly eaten food and beverages if they could not locate certain food items using the Social POD app calorie database.

Features of the Fat Secret app included: 1) a database with commonly consumed foods and beverages as well as items from popular restaurants and supermarkets for tracking of calories consumed from individual food items or dishes (Figure 3.3); 2) a database with commonly engaged physical activities to track calories expended from PA (Figure 3.4); 3) a weight tracker to enter body weight each day with a weight graph to compare changes in weight over time with a goal weight that is set by the participant (Figure 3.5); 4) a recipe index with recipes by category (Figure 3.6).

The Fat Secret app was used to look-up the calorie content of foods and beverages by selecting “Add Food” either from the My Counter screen or the Food Diary screen and an example of the calorie database by Supermarket Brands can be seen in Figure 3.3 below.

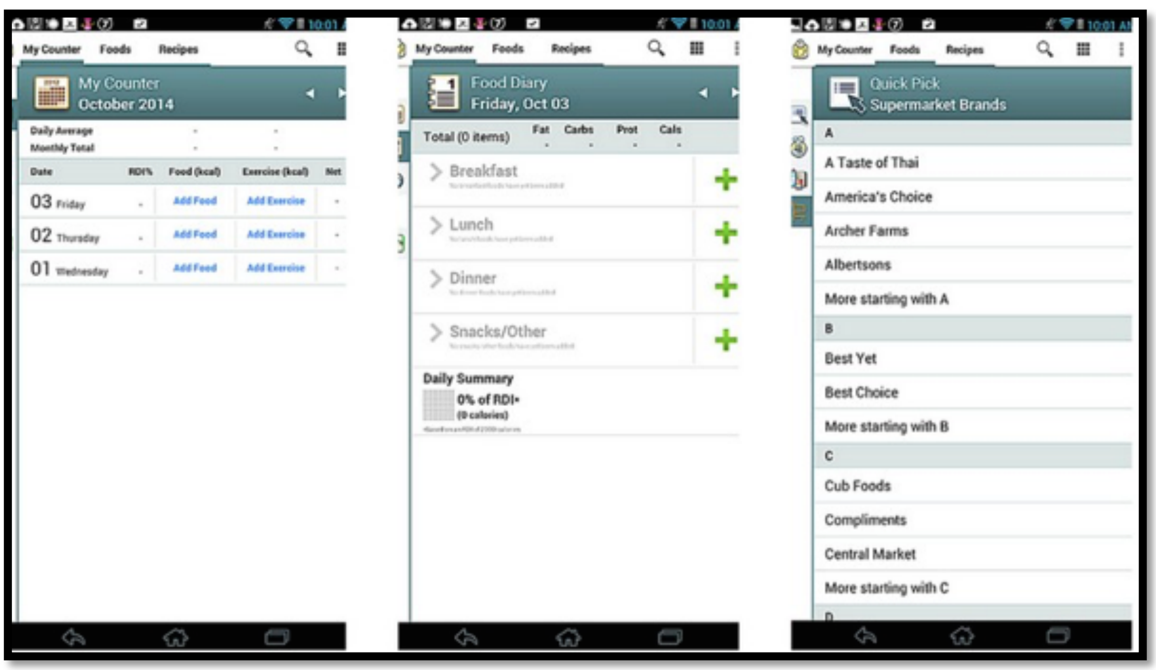

Figure 3.3: My counter, food diary, and calorie database from Fat Secret app.

Comparison group participants were instructed to add minutes of PA completed in the Fat Secret app by selecting “Add Exercise” from the My Counter screen or the

Exercise Diary in the app. To add activity, participants selected the activity completed in the drop-down menu and then selected the amount of time completed. Please see Figure 3.4 for a screenshot of the PA tracking features of the Fat Secret app.

Comparison group participants were instructed to track their body weight daily using the Fat Secret app. On the Weight Tracker in the Fat Secret app there was also a weight graph so that participants could view their current weight in relation to a self-determined goal weight. Comparison group participants were asked to select a goal weight for themselves the first time they logged-into the Fat Secret app. To track weight, participants clicked the "+" icon from the Weigh Tracker in the app to add their current weight. On this screen there was also a place for participants to create a journal entry. Please see Figure 3.5 below for the weight tracking features of the Fat Secret app.

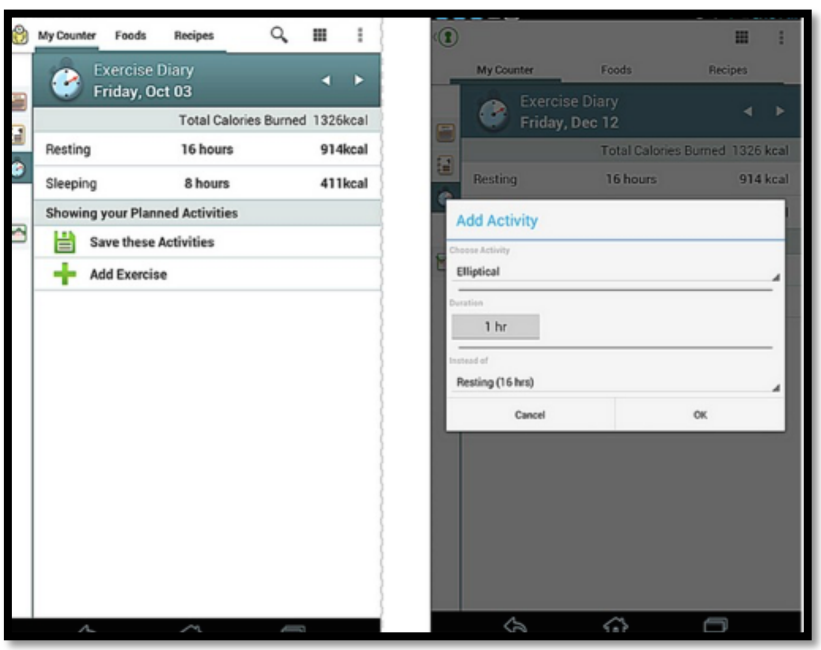

Figure 3.4: Physical activity tracking features of Fat Secret app.

Also included in the Fat Secret app was a database of recipes. Participants were able to search for recipes based on meal-type (breakfast, lunch, etc.). There was also a recipe features page that featured new recipes included in the app database each day. Participants could browse recipes, view nutrition information, and add recipes to their calorie trackers, if desired. Please see Figure 3.6 for the recipe feature of the Fat Secret app.

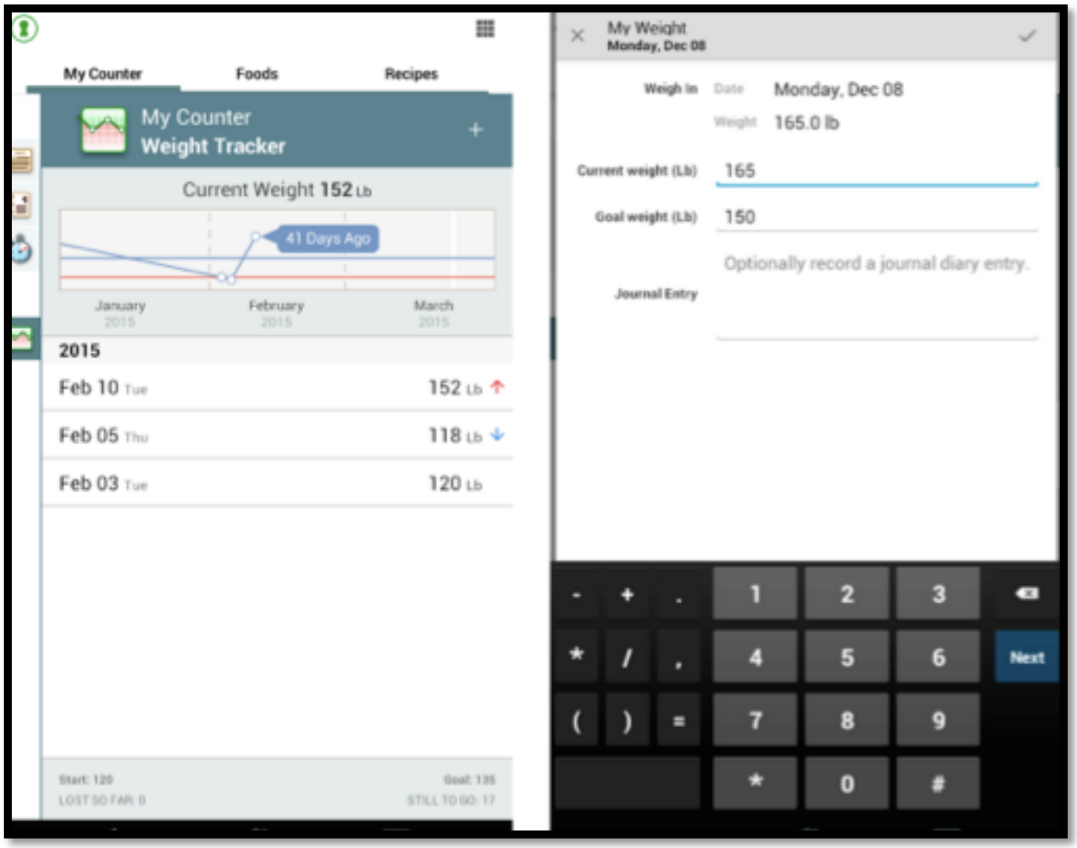

Figure 3.5: Weight graph and weight tracker of Fat Secret app.

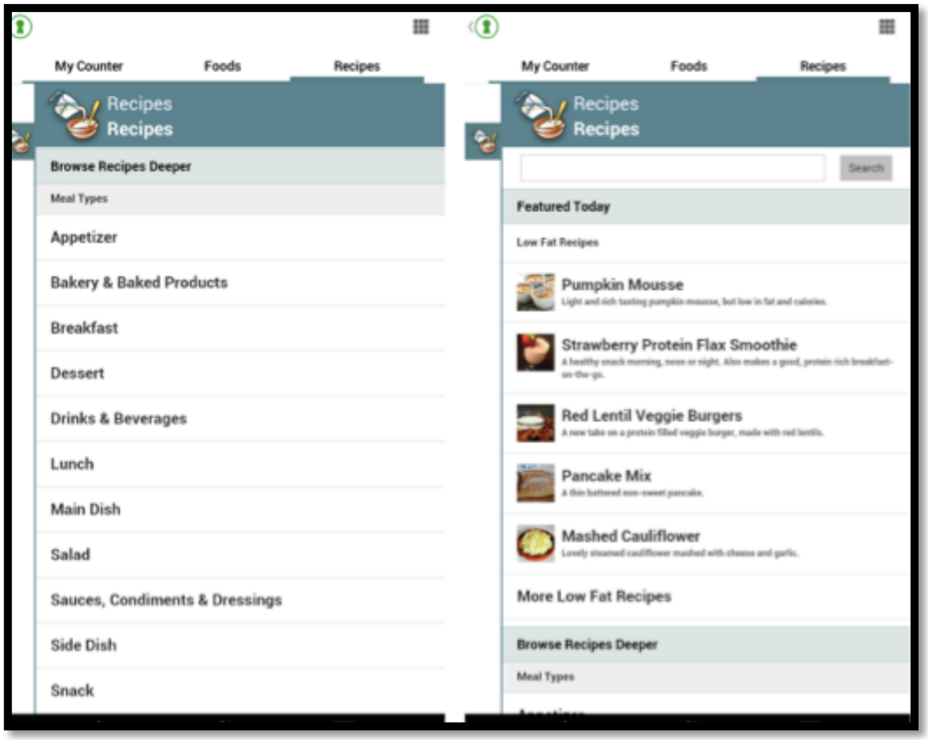

Figure 3.6: Fat Secret recipe database by meal category and featured recipes.

Specific intervention components for Specific Aims 2 and 3 are described in Table 3.4 along with the theoretical construct targeted, and which group received the specified intervention component.[16,19,21]

Table 3.4: Intervention Components and Theoretical Constructs Targeted

Intervention Component	**Theory**	**Construct**	**Study Group**	
			Social POD - Experimental Group	**Fat Secret – Comparison Group**
Nutrition and exercise information presented in podcasts.	Social Cognitive Theory	Outcome expectations and behavioral capability	X	X
Podcast audio diary.	Social Cognitive Theory	Outcome expectations, self-efficacy, and social support with informational, network, and	X	X

		emotional support subtypes.		
Podcast weight loss goal.	Social Cognitive Theory	Self-efficacy and self-regulation	X	X
Diet, PA, and weight tracking features.	Social Cognitive Theory	Self-regulation	X	X
User-user messages	Social Cognitive Theory Ecological Perspective–Interpersonal Level	Self-efficacy and outcome expectations Social support with informational, network, and emotional support subtypes.	X	
Incentive system including goals, newsfeed, and point tracker.	Social Cognitive Theory	Reinforcement	X	

Social POD app detailed description

Similar to the Fat Secret app, the Social POD app included diet, PA, and weight tracking features as well as a calorie database. If the caloric content of a food or beverage items could not be found in the Social POD app database, participants from the experimental group were advised to use the Fat Secret app database, if needed, to determine the caloric content and self-monitor all calories consumed using the Social POD app. To log their calories consumed, experimental group participants clicked the "Calorie Log" icon on the home screen of the Social POD app. Then they could either list the item name and the calorie content or list the item name and search for the calorie content by clicking "Search" on the Calorie Log screen. Calories for foods and beverages were added to the Diet Log by clicking the “Submit” button. Please see Figure 3.7 for the home screen and calorie log features of the Social POD app.

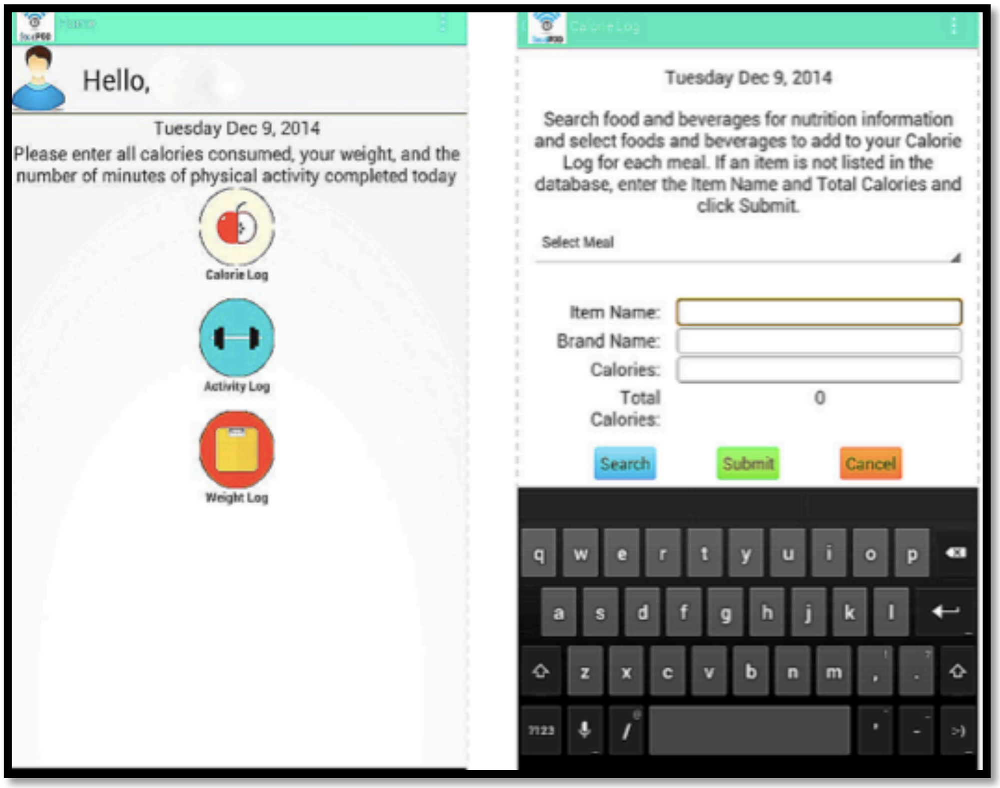

Figure 3.7: Home screen with icons for selecting the calorie log, activity log, and weight log and the calorie log screen.

To enter minutes of PA completed, participants were instructed to click the “Activity Log” icon from the home screen (Figure 3.8, left). Participants then clicked the “Select Activity” and a drop-down menu with several activities appeared. Participants selected the appropriate activity (including options for None and Other) and entered the number of minutes completed, and clicked the “Submit” button. To see a list of all activity entered in the Social POD app, participants could scroll through the Activity Log (pictured on the left of Figure 3.8).

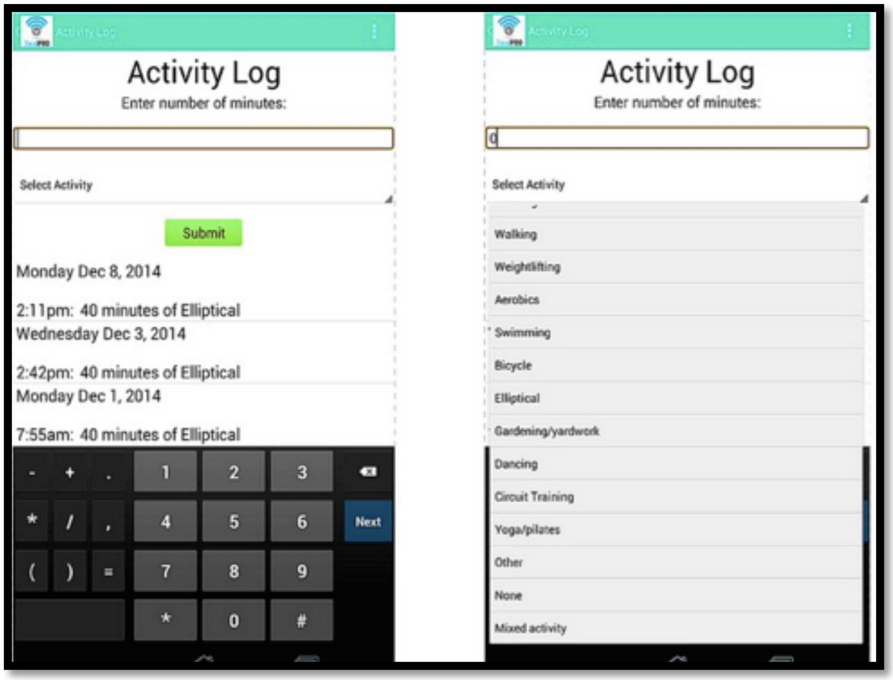

Figure 3.8: Social POD app physical activity tracker and drop down menu with list of activities.

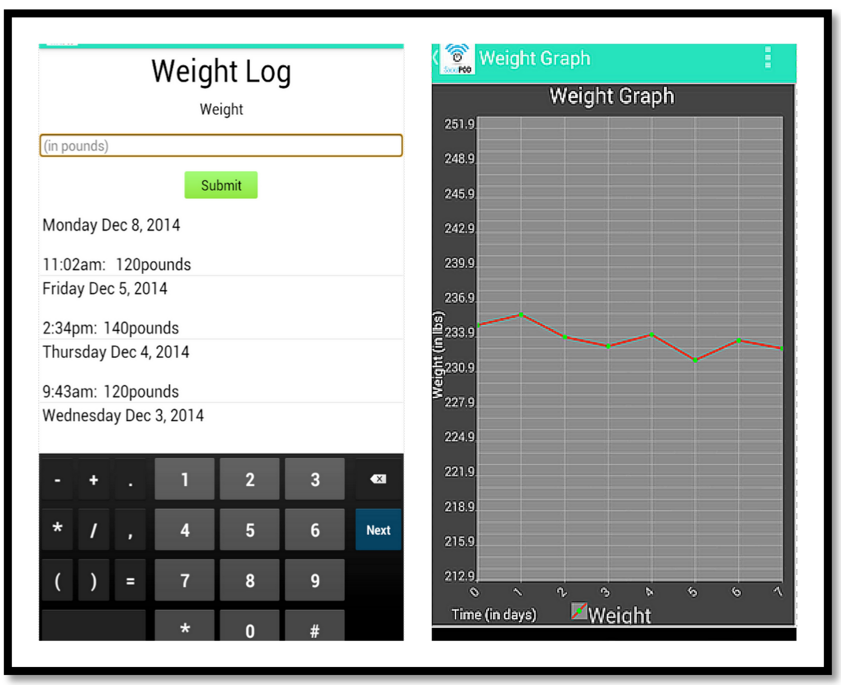

Figure 3.9: Weight tracker and weight graph of Social POD app

To track their weight, participants were instructed to click the "Weight Log" icon on the home screen (Figure 3.7, left). They were then taken to the Weight Log screen, where they entered their total weight (in pounds) and clicked "Submit." For a history of all weight entered in the Social POD app, participants could scroll through their weight history on the Weight Log screen (please see Figure 3.9). Participants could also access a weight graph, which depicted a graphical display of their weight by day, within a 20-pound range of their starting weight (weight entered at the time of download of the Social POD app). The weight graph was updated between the first and second iterations of the Social POD app using a narrower weight-range (20-pound range) targeted around their baseline weight to better depict small weight fluctuations over time. Please see Figure 3.9 (right) for a screenshot of the Weight Graph feature of the Social POD app.

Social POD App User-user Messaging System Description

User-user messages were developed by the research team and revised following usability testing to specifically target social support, self-efficacy, and outcome expectation constructs to re-engage infrequent users (those who have not entered anything in the app in the past 48-hours) with the Social POD app.[17] All revised messages included some form of social support, as they were sent from one user to another. Each message type was coded with the main construct targeted (i.e., social support, self-efficacy, or outcome expectations) and then coded to reflect which sub-type(s) of social support the message provided.

Messages targeting self-efficacy were designed to enhance confidence in performing healthy diet and PA behaviors and managing potential barriers to engaging in self-monitoring.[19] Self-efficacy messages were designed to incorporate informational social support with suggestion, advice, referral, and teaching sub-types to increase self-efficacy for performing healthy behaviors, self-monitoring, and use of the Social POD app. An example of a self-efficacy message targeting barriers and small steps (informational and advice social support) is: "Even though it was hard to figure out calories at first, I found out I can do it pretty easily now. I just take it one day at a time." Another example of a self-efficacy message targeting emotional understanding (empathic social support) is: "Staying on this diet can be a challenge. There are times when I just want to stop but I try to keep in mind how good it with feel to accomplish my weight loss goals."

To increase social support for self-monitoring and use of the Social POD app, social support messages were designed to provide specific types of emotional support including encouragement, empathy, and sympathy as well as network support and companionship and esteem support, relief from blame, and compliments.[13] An example of a social support message with emotional and empathic and encouragement sub-types of support is: "Haven't seen you log anything in the app lately. We miss you!" Another example of a social support message with emotional sympathy support is: "I really feel like having support from others makes things easier – we're all here to support each other in this program."

Messages designed to target outcome expectations for self-monitoring and use of the Social POD app were designed to provide examples of positive outcomes of healthy behaviors related to diet, PA, and weight self-monitoring as well as reframing negative thoughts about these health behaviors.[19] An example of reframing (informational and situational appraisal social support) is: "I'm excited to be focusing on a healthy diet! It's a lot better than all those fad diets out there." Another example outcome expectation message (informational and suggestion support) is: "I'm not at my goal weight yet but seeing the numbers on the scale helps me realize that I still need to work hard to get where I want to go."

The messaging system was designed so that frequent app users (defined as those users who entered data in the Social POD app within the past 48-hours) were prompted via notifications to send an encouraging message to another participant who had not used the app recently (defined as an infrequent user who has not entered data in the Social POD app within the past 48-hours). Frequent users clicked a notification asking them to send an encouraging message to another user who has not used the app as often. Frequent users were then taken to a message selection page where they were able to view three types of messages to select one to send to an infrequent user. The messages displayed included one message option that targeted social support, another message that targeted self-efficacy, and a third message that targeted outcome expectations. The messages were not labeled as to which type of support they provided, and the order of messages was randomized so that no one type of message always appeared in a set order. In the event there were many infrequent users and only a few frequent users of the Social POD app, frequent users could be asked to select and send one message to multiple infrequent users. The senders and receivers of messages were identified in the notifications by study ID number so that participants were aware to whom the messages would be sent and from whom they were receiving messages. Please see Figure 3.10 for the messaging features of the Social POD app.

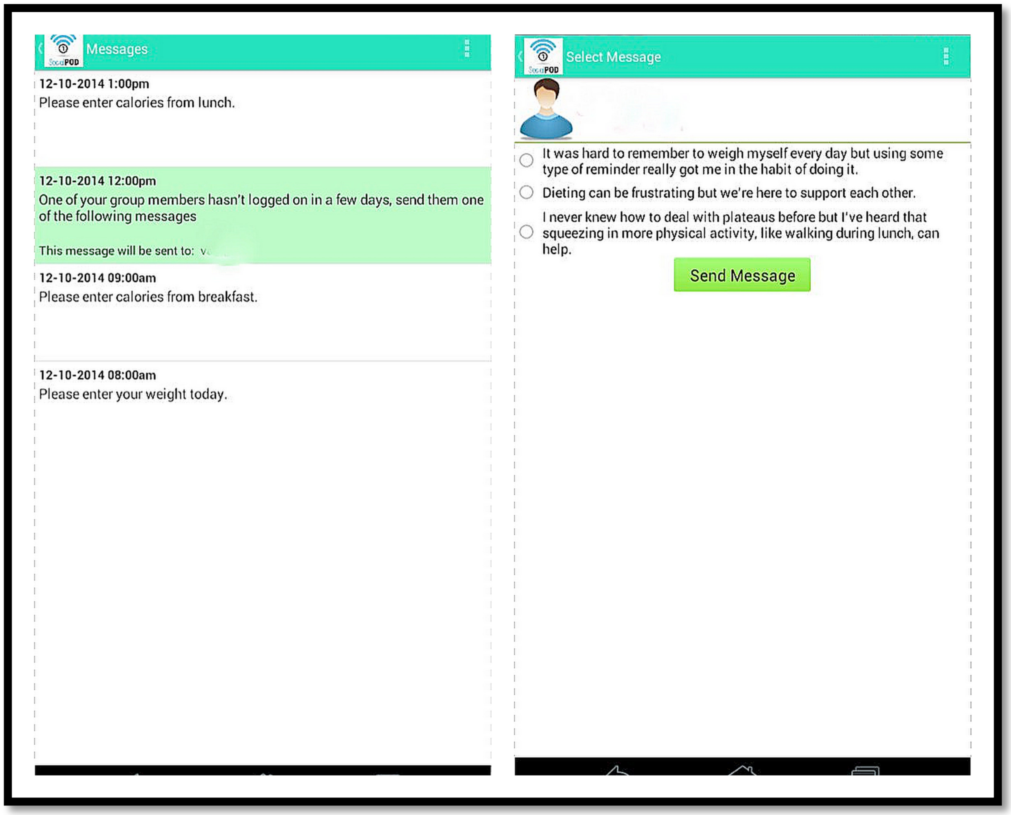

Figure 3.10: Notification to send a message to an infrequent user and message-selection page of the Social POD app.

Social POD Incentive System Description

Based on participant feedback from focus groups following the usability testing of the first iteration of the Social POD app, an incentive system was developed including a goals page, newsfeed, and point tracker. Goals for using the Social POD app for tracking diet, PA, and weight and for sending encouragement ("stars") to others in the study were listed on the goals page of the app. Goals included logging calories from meals and snacks, logging body weight, logging at least 30 minutes of PA, and sending a star to another user. A newsfeed was developed for participants to view the progress of other users with pre-set goals, with the ability to send others encouragement ("stars") for achieving these goals. Participants were able to send stars to each other through the newsfeed to provide praise for achieving weight loss-related goals. A point tracker was also developed for participants to view the number of points earned for self-monitoring diet, PA, and weight and for sending others encouragement through the newsfeed. Points could be redeemed for study-provided prizes following the pilot RCT.

The number of points that a participant could earn was based on the total number of points possible over the course of the study for the following activities: 1) tracking calories every day (one point for logging at least one meal or snack each day); 2) tracking weight every day (one point for doing this one time per day); 3) logging at least 30 minutes of PA per day (one point for logging at least 30 minutes per day); 4) sending a "star" from the newsfeed to participants as encouragement for completing a goal (maximum of one point per day). Participants could earn a total of four points per day for a total of 336 possible points. Prizes, and the number of points needed to earn each prize by level, included: Level One prize of a pedometer, 60 points (18% of possible points); Level Two prize of a pedometer and a sweat towel, 120 points (36% of possible points); and Level Three prize of a pedometer, water bottle, and sweat towel, 180 points (54% of all possible points). Please see Figure 3.11 for screenshots of the Goals and Point Tracker. Please see Figure 3.12 for a screenshot of the Newsfeed and the Notification Center of the Social POD app.

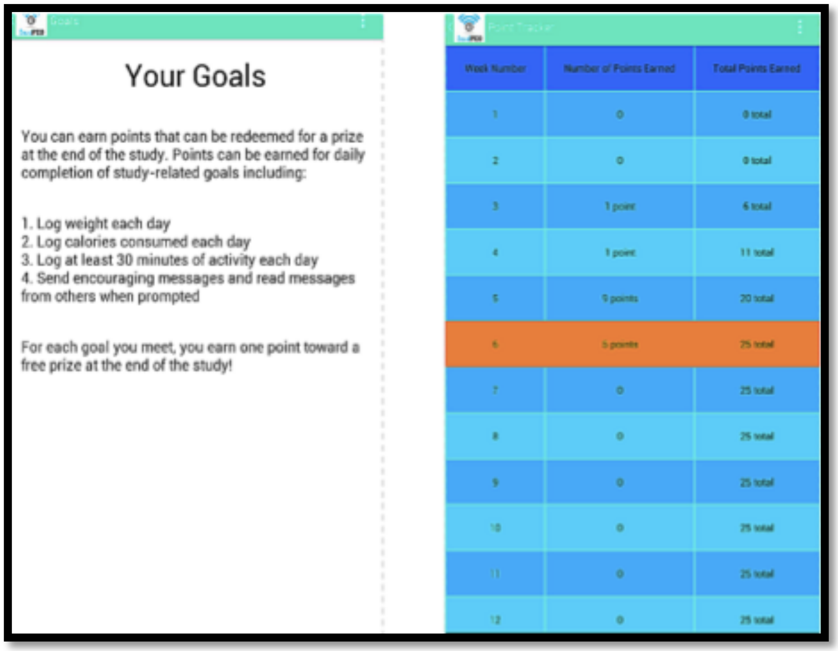

Figure 3.11: The Social POD goals screen and the point tracker

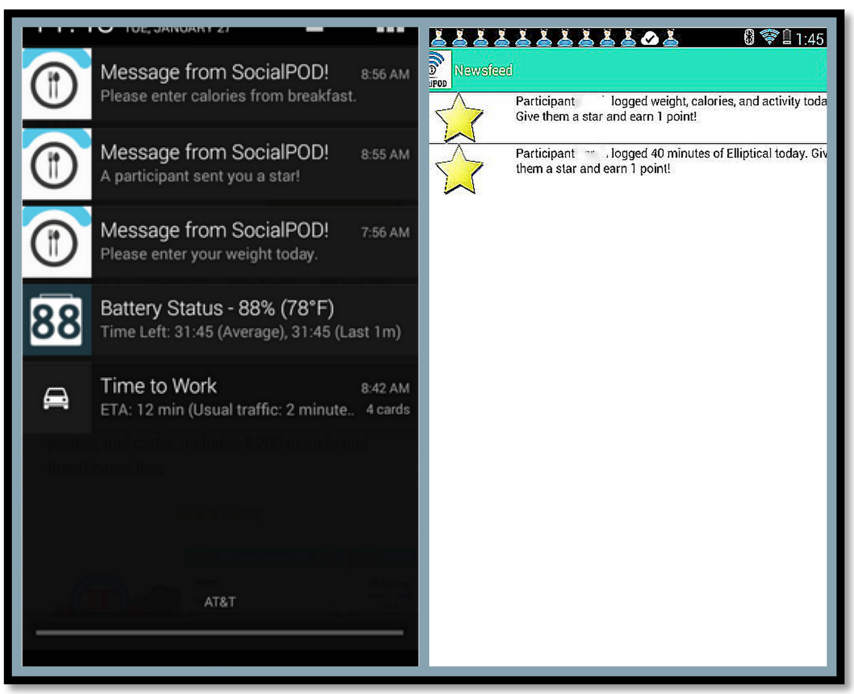

Figure 3.12: Notifications in the device-specific notification center and newsfeed of the Social POD app.

Other features of the Social POD app included a notes page and help screen. For screenshots of these features please see Figure 3.13. The notes screen was suggested by participants in focus groups during usability testing. The notes screen was a place for participants to make note of anything that related to their weight loss. Participants were instructed that the notes page was confidential and the only people that will see what is written in this page were study staff. The help screen lists directions for using all components of the Social POD app. Participants were instructed to use the help screen if they experienced problems remembering how to use any features of the Social POD app. Participants were instructed to contact the study coordinator if they needed additional assistance with the Social POD app.

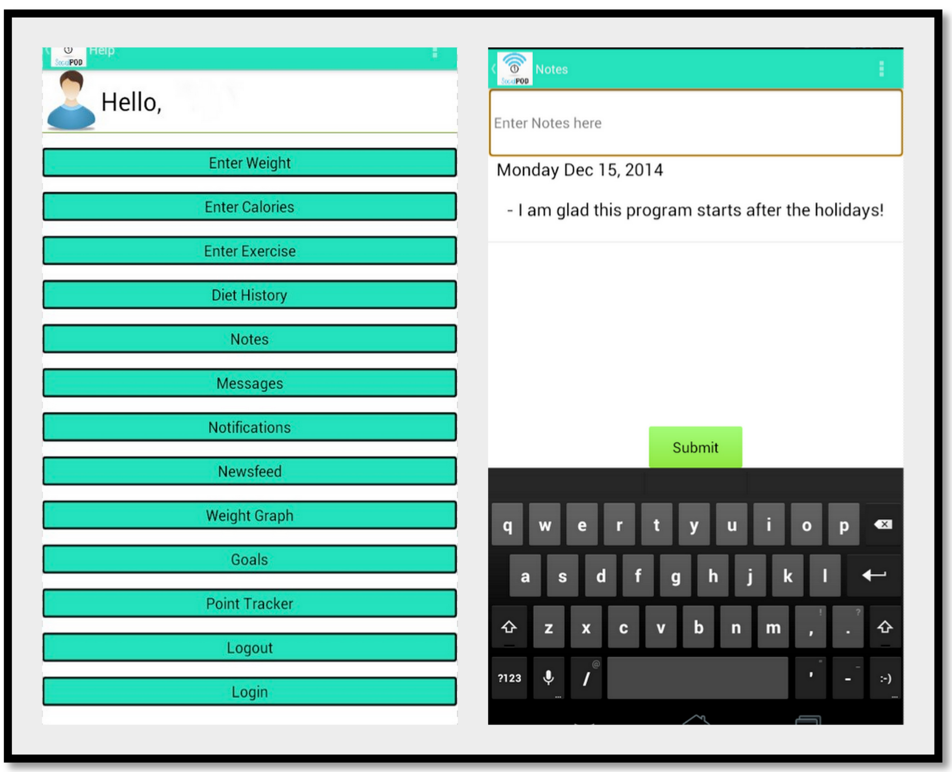

Figure 3.13: Help and notes screen of the Social POD app.

Description of Intervention Methods for Specific Aims 2 and 3

Below is a description of tasks accomplished at each session as well as tasks completed throughout the study. First, all interested participants were instructed to complete an online pre-screening assessment to determine if they met basic study inclusion criteria (e.g., BMI, are between the ages of 18-65, have an Android device). Participants who did not qualify for the study based on our inclusion/exclusion criteria were sent an email notifying them of this and thanking them for their interest in the study.

Participants who qualified based on our study criteria were called by the Study Coordinator to review all information provided on the online screener and to confirm contact information and rule out any medical conditions/current medications excluding them for participation. In addition, a detailed description of the study was provided and participants were asked if they still wished to participate. If participants agreed to participate in the study following the phone interview, they were asked to chose a date to attend an orientation session on the University of South Carolina campus or at The Citadel in downtown Charleston. Weekday evenings were selected for the sessions to accommodate most work schedules.

Recruitment began in October of 2014 and the orientation sessions were not scheduled until January of 2015, therefore periodic email newsletters developed by research staff were sent to participants to check-in over time and ensure that participants were still interested in participating in the study. The newsletters did not provide any information pertinent to the study (i.e., no information was provided regarding food, diet, weight, or PA). Newsletters were sent via email every other week beginning on Tuesday, October 28, 2014 through Tuesday, December 23, 2014.

At the orientation session, the Study Coordinator reviewed the Informed Consent document with all participants and those who wished to participate signed and dated their forms (keeping one and giving one to study staff). Participants were given another detailed description of the study presented by the study coordinator using a power point presentation. Participants received a study ID and password and instructions for completing their questionnaires online prior to the training session. Participants were instructed to return to campus in two weeks for a training session and to complete baseline weight and height measurements. Prior to the training session, participants completed a baseline assessment questionnaire and two dietary recalls (one weekday and one weekend day) using the ASA24 on a personal computer. Participants who completed the baseline questionnaire and ASA24 assessments were randomized to one of two groups and instructed to attend a training session with a choice of two weekday evenings. Participants were not informed as to whether they were assigned to the experimental or comparison group until they arrived at the training session. A computer program was used to randomly assign participants to their groups at one time after all had completed baseline assessments. The computer program that was used for randomization was Randomizer.org[79] from the Social Psychology Network. Randomizer.org was used to generate a random list of 104 numbers consisting of 1's and 2's (1= experimental group and 2= comparison group). After all participants completed baseline measures, they were assigned to a treatment group, by random number.

At the training sessions (two weeks after the orientation session), participants received instruction regarding how to access the podcasts, download and use their assigned app(s) (Social POD/Fat Secret), and complete weekly questionnaires.

Participants in both groups were instructed to weigh themselves at the same time each day to ensure accurate weight was reported due to fluctuations in body weight throughout the day. There were separate training sessions for comparison and experimental group participants. In Columbia, there was a session for each group, held concurrently, lead by study staff members. In Charleston, there were separate sessions held for each group throughout the week because there was only one staff member able to lead the sessions in this location. Both groups received the intervention beginning on Monday February 16th, 2015 (with the exception of two participants who were unable to use the Social POD app until the following week due to technical issues).

During the course of the study, participants were asked to complete weekly surveys online assessing their use of the podcasts, weight loss apps (Fat Secret or Social POD app). Experimental group participants were asked to list any functionality issues experienced during the week with the Social POD app and provide suggestions for improvements to the app on their weekly surveys. Participants received the link to weekly surveys via email every Friday for the duration of the twelve-week study. To access weekly surveys, participants were instructed to enter their study ID and first and last initials. For any functionality issues experienced during the study, participants in both groups were asked to directly and immediately contact the study coordinator by email or phone to resolve any potential issues preventing participants from using their respective tracking apps. Participants received web links for the 24 podcasts via email every Tuesday and Thursday for the duration of the study. To log into the podcast-hosting site, participants were instructed (and required) to enter their study ID and first and last initials.

At mid-study (week six), the study coordinator reviewed all weekly surveys completed for weeks five and six, and contacted any participants who reported not listening to podcasts or using tracking apps during these weeks. The coordinator also contacted participants who did not complete surveys for these weeks. Any technical issues with the podcasts and tracking apps were resolved and participants were encouraged to listen to the podcasts and use their respective tracking app on a daily basis for the remainder of the study. During week six, the study coordinator also reviewed the total number of points earned by experimental group participants and sent each participant an email congratulating them on points earned to date and mentioned how many prizes were earned and the number of points needed to earn additional prizes.

At the end of the study (month three), participants were contacted by email, phone, and text and asked to complete the post-study questionnaire and two days of unannounced ASA24 recalls (one weekday and one weekend day). Participants were also instructed to attend an end of study meeting offered on weekday evenings. At the end of study meeting, final weight measurements were obtained for all participants in both the comparison and experimental groups, participants received compensation ($10 total) for completing all study-related assessments, and experimental group participants also received their prizes for points earned throughout the study. All participants in both groups received a prize (a pedometer) for attending the final session and participating in the study. The study coordinator also collected objective measures of diet self-monitoring by asking all participants to report all meals and snacks logged, the tracking app used to log calories from meals and snacks, and total calories for the previous three days prior to the end of study session attended. Any participants who did not complete the final questionnaire or any remaining dietary recall assessments were asked to do so using laptops provided by study staff at the end of study meeting. Participants were not told before attending the meeting that they could complete their recalls at the end of study meeting, to ensure these measures were still unannounced. Please see Table 3.5 below for a list of dates for the three face-face meetings for this study.

Table 3.5: Detailed Study Meeting Schedule for Specific Aims 2 and 3

Meeting	City	Location	Group Attending	Room	Dates	Time
Orientation Sessions	Columbia	USC: Discovery Building	All	DISC 331	January 12th & 13th	5:30-6:30pm
	Charleston	The Citadel	All	Deas Hall 218	January 14th & 15th	5:30-6:30pm
Training Sessions	Columbia[1]	USC: Discovery Building	Experimental	DISC 140	February 2nd	5:30-7:30pm
			Comparison	DISC 530		
			Experimental	DISC 140	February 3rd	5:30-7:30pm
			Comparison	DISC 331		
	Charleston	The Citadel	Experimental	Deas Hall 219B	February 9th	5:30-7:30pm
			Experimental	Deas Hall 219B	February 10th	
			Comparison	Deas Hall 219B	February 11th	
			Comparison	Deas Hall 219B	February 12th	
End of Study Sessions	Columbia	USC: Discovery Building	All	DISC 140	May 11th & 12th	5:30-7:30pm
	Charleston	The Citadel	All	Deas Hall 219B	May 13th & 14th	5:30-7:30pm

Outcome Measures and Variables for Specific Aims 2 and 3

Participants completed all questionnaires (baseline, weekly, and post-intervention) online using a secure website and information was stored on secure servers housed on the University of South Carolina campus. Questionnaires assessed demographic characteristics at baseline only. In addition, measures of height (SECA 213, using a calibrated stadiometer at baseline) and weight (SECA 869, Hamburg, Germany, calibrated digital scale accurate to 0.01 kg) were measured at baseline and end of study (month three).

Dietary measures were completed by participants using the National Cancer Institute's Automated Self-Administered 24-hour Dietary Recall (ASA24).[67] Each participant completed the ASA24 online for one unannounced weekday and one unannounced weekend day at baseline and end of study (month three).

The following assessments were completed online by participants at baseline and three-months: Paffenbarger Physical Activity Questionnaire,[68] Weight Efficacy-Lifestyle Questionnaire,[69] Big Five Inventory,[70] Sallis Social Support Scale,[71] Stanford Expectations of Treatment Scale, [80] and an adapted version of Treatment Self-Regulation Questionnaire.[81,82] Objective measures of frequency and duration of podcast (both groups) and app use (experimental group only) were collected over the course of the study. In an effort to capture objective data for diet self-monitoring, all participants were asked to report all meals and snacks logged, the tracking app used, and the total calories for the previous three days prior to the end of study session date. All baseline measurements were collected before participants received the weight loss intervention. A weekly questionnaire was completed online by experimental and comparison groups to assess use of podcasts and apps during the course of the study and to determine if any participants joined another weight loss program during the course of the study. A process evaluation questionnaire was also part of the post-test at month three.

Data Collection and Management Procedures for Specific Aims 2 and 3

Participants reported use of the podcasts and Social POD and Fat Secret apps on the weekly surveys as well as on the post-test process evaluation. Podcast usage data were also collected objectively from the secure website used by participants to access the podcasts. All data entered in the Social POD app were collected unobtrusively by the secure network server housed on the University of South Carolina campus. Data entered into the Social POD app were saved on the secure database and routinely backed-up to prevent loss of data during the course of the study.

All survey data (i.e., baseline, post-test, and weekly surveys) were stored on secure university servers (password protected electronic folder on the Arnold School of Public Health “V” drive) and accessed on password-protected devices. Data from online surveys were exported via Microsoft Excel documents and stored on password-protected computers using the secure and password-protected “V” drive. All paper documents (i.e., consent forms and physician consent forms) were maintained by the Principal Investigator (PI), Dr. Brie Turner-McGrievy, and stored in a locked drawer in a locked office in a locked building on the University of South Carolina campus in the Discovery Building in Columbia, S.C.

Trained research staff including the PI, the study coordinator, and trained graduate research assistants completed all height and weight measurements at baseline and three months. All study staff utilized the same measurement protocol to ensure there were no differences in how height and weight measurements were obtained.

Protection of Human Subjects for Specific Aims 2 and 3

Participants recruited for this research included overweight and obese adults between the ages of 18 and 65 and not meeting any of the aforementioned exclusion criteria. Only participants who provided consent to participate in the study and were willing to be randomized to the intervention or comparison group were included in the study. Anticipated risks of participation in this research study were minimal and included collection of some personal information regarding health and dietary habits but this information was identified by a study ID number and not identified by participant name.

In an effort to minimize risks, participant confidentiality was maintained at all times. Participants were referred to by a study ID and only one document linked identifying information with study ID. All electronic documents were stored on secured university network servers and on password protected computers.

Participants were provided with a $10 incentive for completion of each assessment measure. This research was designed to benefit society by gaining new knowledge about the use of social networks to help provide support and encouragement during a weight loss intervention. The benefits to individuals could include learning new information about healthy eating. Individuals could also lose weight, which may help to reduce risk of developing chronic diseases such as diabetes, some forms of cancer, or heart disease. Individuals could also learn new and healthy cooking tips as well as tips when dining out.

A number was assigned to each participant at the beginning of the project. This number was used on project records rather than names, and no one other than the research staff was able to link IDs with names. A participant ID number was assigned to use on all surveys and participants chose their username for the Fat Secret app and were assigned an ID if using the Social POD app, which did not identify them (e.g., a pseudonym or made up name). Study related documents that were stored on end-user/portable devices were kept secure by ensuring that all devices are password protected and all servers are password protected as well.

The Principal Investigator and Study Coordinator monitored for the safety of all participants in this research. The participants were monitored for any adverse events during their participation in this study. There were no adverse events as a result of participation in this research. Participants were advised of their right to withdraw their participation in the study at any time, with no adverse consequences. IRB approval was obtained from the University of South Carolina and the IRB provided all oversight and monitoring for this research study.

Data Analysis for Specific Aims 2 and 3

Stata version 13 for Macintosh was used for all quantitative data analysis. Assumptions of statistical tests were checked for all aims. Independent samples *t*-test was used to assess differences in baseline demographic characteristics among experimental and comparison group participants. Independent samples *t*-test was also used to assess group differences in kilograms lost at three-months. As psychosocial characteristic scores violated the assumption of normality for Independent samples *t*-test, analysis of covariance (ANCOVA) was used to assess statistical significance between final outcome scores and baseline scores (continuous covariate) and group assignment in the models comparing group differences in final self-efficacy, social support, and outcome expectation scores with group assignment and baseline scores included as covariates

(Specific Aim 2b). As there were too few observations to use a logistic regression model, Fisher's exact test was used to determine the statistical significance of the relationship between the type of message received and viewed by infrequent users and re-engagement of infrequent users (Specific Aim 3b).[83] Below the analysis plan for Specific Aims 2 and 3 is presented and organized according to aim and sub-aims.

Aim 2a: Conduct a three-month pilot RCT among overweight and obese adults (N=51) comparing a TBP plus self-monitoring using the FatSecret app versus TBP plus self-monitoring with the Social POD app from February to May of 2015.

Hypothesis 2a: Participants in the experimental group (TBP+Social POD) will lose significantly more weight than those in the comparison group (TBP+FatSecret).

Analysis Plan 2a: Independent samples *t*-tests will be used to detect significant between-group differences in kilograms lost at three-months.

Hypothesis 2b: Participants in the experimental group will have a significantly greater increase in social support, self-efficacy, and outcome expectation scores than those in the comparison group.

Analysis Plan 2b: Final social support, self-efficacy, and outcome expectation scores at three months will be examined using separate ANCOVA models for each of the psychosocial variables. In the models, the dependent variable will be the final score for social support, self-efficacy, or outcome expectations with covariates including group assignment and baseline scores for each variable.

Aim 3: Within the experimental group**,** examine specific app features as predictors of weight loss and engagement.

Aim 3a: To determine if the number of points earned by experimental group participants is associated with weight loss at three-months (TBP+Social POD app).

Hypothesis 3a: The number of total points earned will be significantly associated with percent weight loss at three-months, such that the more points a participant earns the more weight they will lose.

Analysis Plan 3a: Linear regression with a continuous outcome of percent weight loss at three-months was used and the predictor was total number of points earned.

Aim 3b: To determine which type of message is sent most frequently among participants in the experimental group. To determine if the type of message received (social support, self-efficacy, or outcome expectations) is significantly associated with re-engagement with the Social POD app among infrequent users.

Hypothesis 3b: Messages targeting social support will be sent more frequently than messages targeting self-efficacy and outcome expectations. Messages received by users that target social support will prompt greater re-engagement than self-efficacy or outcome expectations messages.

Analysis Plan 3b: A frequency distribution was used to determine differences in the number of messages sent to infrequent users from each social construct category (social support, self-efficacy, or outcome expectations). Fisher's exact test[83] was used to determine if the type of message received and viewed was significantly associated with re-engagement with the Social POD app among infrequent users after a period of 24-hours.

Process Evaluation and Implementation Monitoring Plan for Specific Aims 2 and 3

To monitor the implementation of the intervention in the comparison and experimental groups, participants completed weekly surveys reporting their use of the podcasts and tracking apps. Objective measures of reach were obtained by monitoring the number of "clicks" on each podcast episode from the podcast hosting website. Objective data regarding app use for the experimental group were obtained from the study database, which captured all data entered into the Social POD app by participants over the course of the intervention. Due to the inability to download data entered from the Fat Secret app, participants were asked about the frequency of app usage (entering calorie, weight, and PA information) on a weekly basis. In an effort to capture objective data regarding self-monitoring behaviors from participants in the comparison group, study staff viewed and recorded the number of meals or snacks entered and the calorie amounts entered during the past three days prior to the end of study meeting. The investigators noted if the participant tracked any items for breakfast, lunch, dinner, and snacks for the three previous days. A process evaluation survey was also included in the post-intervention questionnaire to assess if participants in both groups received and were using the intervention as intended.

CHAPTER 4

RESULTS

4.1: THE SOCIAL POD APP: A MIXED-METHODS APPROACH TO THE DEVELOPMENT, REFINEMENT, AND PILOT TESTING OF A MOBILE APPLICATION FOR IMPROVING HEALTHY BEHAVIORS[1]

[1] Hales, S., Turner-McGrievy, G.M., Fahim, A., Freix, A., Wilcox, S., Davis, R.E., Huhns, M., and Valafar, H. In press at *Journal of Medical Internet Research – Human Factors,* 11/11/2015.

Abstract

Background: Mobile health (mHealth) has shown promise as a way to deliver weight loss interventions, including interconnecting users for social support.

Objective: To develop, refine, and pilot test the Social Pounds Off Digitally (POD) Android app for personalized health monitoring and interaction.

Methods: Adults who were overweight and obese with Android smartphones (BMI 25-49.9 kg/m^2; N=9) were recruited for a two-month weight loss pilot intervention and iterative usability testing of the Social POD app. The app prompted participants via notification to track daily weight, diet, and physical activity behaviors. Participants received the content of the behavioral weight loss intervention via podcast. In order to re-engage infrequent users (did not use the app within the previous 48 hours), the app prompted frequent users to select one of three messages to send to infrequent users targeting one of three behavioral theory constructs: 1) social support, 2) self-efficacy, or 3) negative outcome expectations. Body weight, dietary intake (two 24-hr recalls), and reported calories expended during physical activity were assessed at baseline and two months. All participants attended one of two focus groups to provide feedback on use of the app.

Results: Participants lost a mean of -0.94 kg (±2.22 kg, p=0.24) and consumed significantly fewer kcals post-intervention (1570±508 kcal/day) as compared to baseline (2384±993 kcal/day, p=0.01). Participants reported expending a mean of 171 kcal/day (± 153 kcal/day) during intentional physical activity following the intervention as compared to 138 kcal/day (± 139 kcal/day) at baseline, yet this was not a statistically significant difference (p=0.57). There was not a statistically significant correlation found between

total app entries and percent weight loss over the course of the intervention (r=0.49, p=0.19). Mean number of app entries was 77.2 ± 73.8 per person with a range of 0 to 219. Messages targeting social support were selected most frequently (n=32, 46%), followed by self-efficacy (n=29, 40%), and negative outcome expectations (n=10, 14%). Themes from the focus groups included functionality issues, revisions to the messaging system, and the addition of a point system with rewards for achieving goals.

Conclusions: The Social POD app provides an innovative way to potentially re-engage infrequent users by encouraging frequent users to provide social support. While there is time needed upfront to develop the intervention, this mHealth intervention can be disseminated broadly for many years and to many individuals without the need for additional intensive in-person hours.

Key Words: mHealth, obesity, weight loss, social support, social cognitive theory

Introduction

Rates of overweight and obesity remain high among US adults at 69% (Body Mass Index: BMI > 25 kg/m^2).[1] Overweight and obesity are associated with type 2 diabetes, cardiovascular disease, arthritis, asthma,[2,3] and some cancers such as thyroid,[4] colon, breast (in postmenopausal women), endometrium, esophagus, and kidney.[5] Behavioral interventions that target improvements in diet and physical activity (PA) are an effective way to help people lose weight and decrease chronic disease risk factors.[6]

The use of apps on mobile devices (i.e. smartphones and tablets) has the potential to improve how individuals monitor health behaviors by serving as a convenient platform to connect users to one another via online social networks. Mobile health (mHealth) holds promise as an effective method of delivering behavioral interventions to improve health behaviors, such as improving diet and physical activity, and is less time-intensive than in-person, individual or group sessions.[7] Mobile phone ownership is pervasive, with 85% of U.S. adults reporting ownership of a mobile phone—with half being smartphones.[8]

Smartphone ownership cuts across ethnicity groups with 49% of Hispanics, 47% of African Americans, and 42% of Caucasians owning smartphones.[8] While there has been emerging research in the area of using mHealth technologies to help people achieve a healthy weight, few studies have used an entirely mobile device-based approach to deliver a behavioral weight loss intervention. Furthermore, many of the mobile-based weight loss apps available (both free and paid) do not include many of the evidence-based techniques used in traditional (i.e., clinic-based) weight loss interventions.[9,10]

In addition to advances in mHealth, weight loss programs have been developed and delivered via internet and other web-based platforms as well as through social media (e.g., Facebook[11] and Twitter[12]) to promote weight loss and reduce health risks of chronic disease. Participant engagement with social media (i.e., frequent use of social media) in the context of these weight loss interventions has been shown to be related to weight loss.[11–13] While there are many benefits of delivering weight loss interventions using remote methodologies, maintaining participant engagement over time, as well as providing sufficient social support in these types of interventions, can be a challenge.[14]

The overarching objective of this line of research has been to design an app that can be used to monitor and test scientific hypotheses related to optimal matching of participants to provide support for collective weight loss in the context of mobile weight loss interventions. The primary goal for this specific pilot study was to solicit participant feedback to refine the Social POD app for use in a larger pilot randomized clinical trial (RCT). The Social POD app was developed by a transdisciplinary team of researchers including experts in health behavior, nutrition, computer science, psychology, exercise science, and social work. The analysis sought to answer: 1) what features of the Social POD app needed to be refined or developed to further incentivize participants to use the app?; 2) were there any significant changes from pre- to post-study in participant weight, calories consumed, and reported intentional physical activity?; and 3) was participant weight loss correlated with frequency of app use over the course of the study?

Methods

Participant Recruitment

Men and women who were overweight and obese with Android smartphones (Body Mass Index 25-49.9 kg/ m^2; N=9) were recruited in South Carolina for a two-month weight loss pilot intervention to test the usability and provide feedback to be used in the refinement of the smartphone app. Participants were recruited via worksite listserv announcements, flyers, and newspaper advertisements. Exclusion criteria included not having an Android phone, previous stroke or heart attack diagnosis, diagnosis of diabetes and using insulin or oral medications to control diabetes, BMI outside the range of 25.0-49.9 kg/m^2, unable to attend required meetings, unable to access the internet using a computer for completing assessments, having a psychiatric illness, receiving treatment for drug or alcohol dependency, having an eating disorder, participating in another weight loss program, being pregnant or planning on becoming pregnant during the study, or breastfeeding. Participants were excluded for endorsing items one through four on the revised Physical Activity Readiness Questionnaire (PAR-Q)[15,16] including: informed by a doctor that they have a heart condition and should only participate in physical activities approved by a doctor, feeling chest pain when engaging in physical activity, experiencing chest pain in the past month when not engaging in physical activity, and ever losing their balance and becoming dizzy or ever losing consciousness. If participants reported a bone or joint problem that could be made worse by participating in physical activity (item five of the PAR-Q) or taking blood pressure medication (item six of the PAR-Q) they were required to have a physician consent form completed to participate in the study. Participants received a total of $30 for completion of assessments at baseline, one-month focus group ($15), and two-month follow-up weight assessment ($15).

Intervention Implementation

Participants attended a total of four in-person meetings, which included: an orientation session to learn about the study and complete baseline dietary assessments; a training session to learn how to download and use the Social POD app and podcasts and to collect baseline height and weight measurements; a mid-study focus-group at one-month to provide feedback regarding the usability of the Social POD app, provide suggestions for improvement, and complete one-month weight measurements; and an end-of-study session to provide two-month weight measurements. All participants provided written consent. This study was approved by a university institutional review board.

Participants were instructed to track their: total calories from all meals, snacks, and beverages consumed (diet); minutes of intentional physical activity; and body weight each day for the duration of the two-month usability study. Participants were instructed to use MyFitnessPal or LoseIt, which are free commercial diet tracking apps with extensive nutrient databases, to look-up calorie information for food and beverages consumed. Participants were then asked to transfer total calories from each meal and snack consumed for the day to the Social POD app. Screenshots of the tracking features are shown in Figure 4.1.

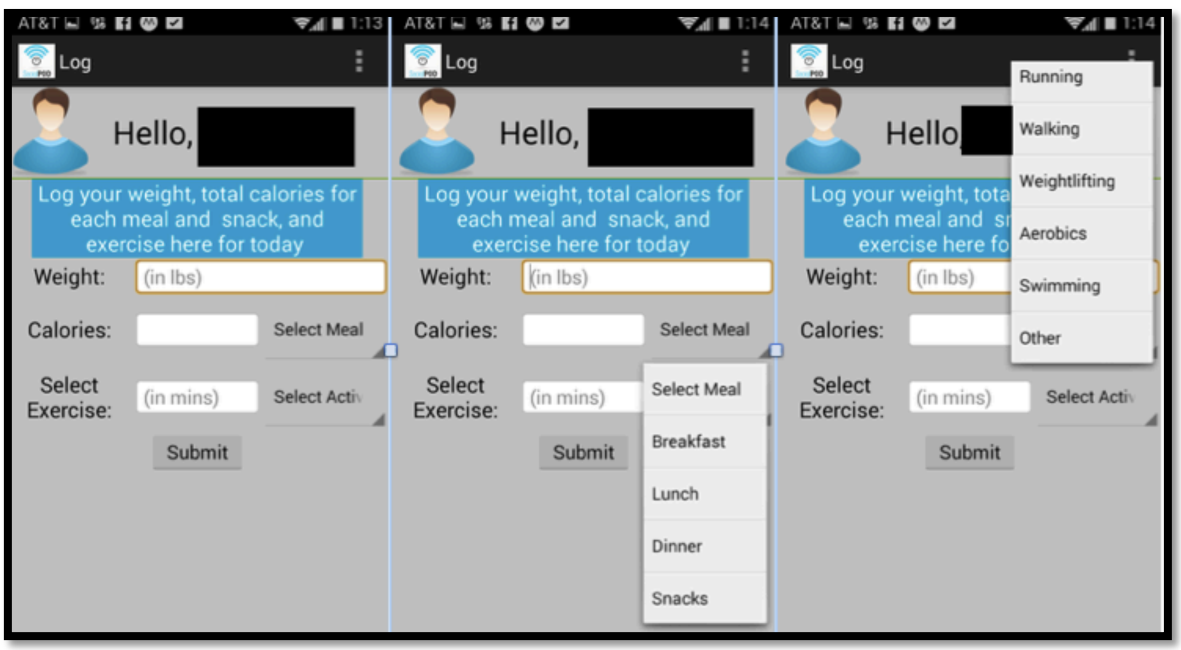

Figure 4.1: Screenshots of Social POD app (left to right) home, meal tracking, and physical activity tracking screens.

Participants received within-app notifications at certain times throughout the day to remind them to self-monitor (promoting self-regulation) diet, minutes of physical activity, and total body weight each day. Participants could view a history of all dietary, activity, and weight information entered on the within-app history screen. Participants could view weight entered on a weight graph. Participants who were frequently using the Social POD app (users who entered information in the app in the past 48-hours) were prompted, via notifications, to send encouraging messages to other group members who did not enter data in the app over the previous 48-hours. Participants who did not enter information in the app in the past 48-hours were infrequent users. Messages were sent from frequent users by clicking the notification to send a message to an infrequent user, selecting one of the messages from the three options listed on the message selection screen, and clicking "send."

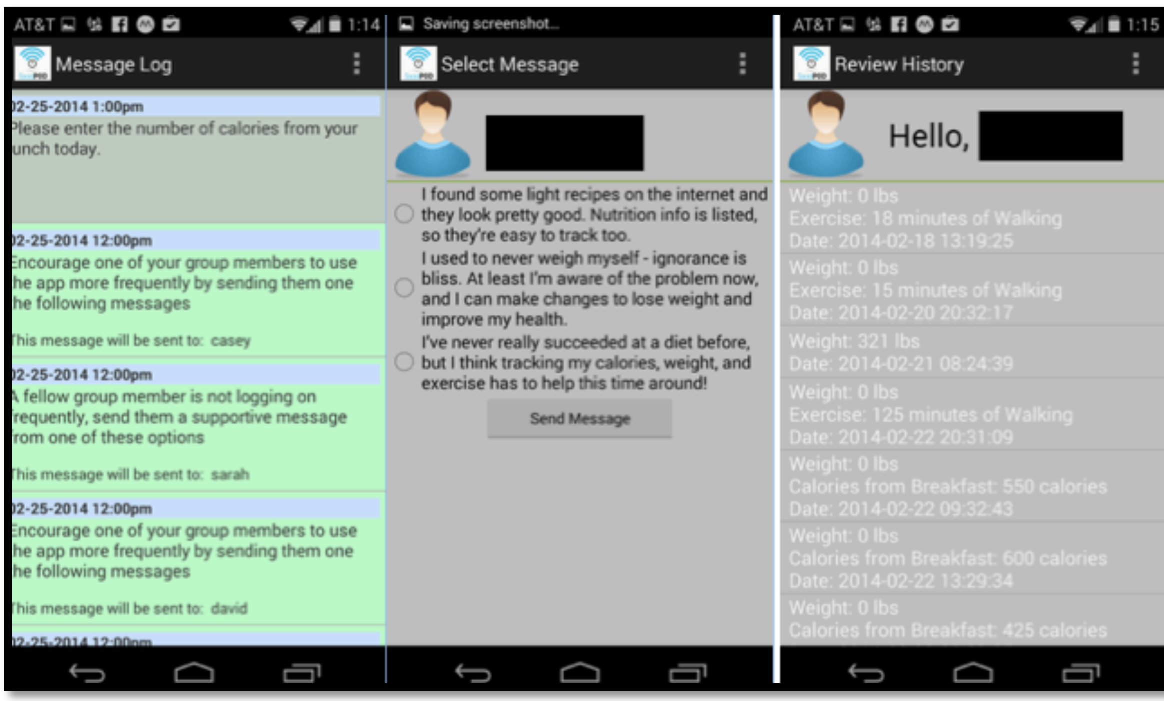

Figure 4.2: Screenshots of the message log, message selection, and history screen of Social POD app.

This mobile study is novel in that it utilized theory-based messages designed by the interventionists to help re-engage infrequent participants over the course of the two-month intervention. The participants were matched to provide support to one another based on principles of recommender systems utilized in some websites and applications (e.g., Amazon and Netflix),[17–20] which filter information to match users based on user history or preferences.[21] Frequent users were randomly matched to provide support (by sending a theory-based message) to help re-engage infrequent users in this intervention. Social Cognitive Theory (SCT)[22,23] was used as a framework to design user-to-user messages that targeted social support[13], self-efficacy[22,23], and outcome expectations[24] regarding self-monitoring behavior (i.e., targeting self-regulation)[23] of diet, physical activity, and weight. SCT is the belief in the reciprocal relationship between cognitions, environmental influences, and behavior.[22,25] Constructs from SCT were selected for this study based on results from a previous Internet-based weight loss intervention, which found that targeting these specific constructs led to healthier diet and physical activity behaviors and resulting in a reduction of body weight among study participants.[26] The interventionists created 36 messages for each of the three social construct theories allowing the potential for a frequent participant to receive up to 46,656 unique message combinations, from which to choose one message to send to an infrequent user. Table 1 provides examples of each message-type as well as the SCT construct targeted.

Table 4.1: User-to-User Message Types by Social Cognitive Theory Construct Targeted

SCT Theory Construct Targeted	Construct Definition	Sample Message
Self-Efficacy	One's belief in their ability to perform specific tasks and overcome barriers.	"I found some light recipes on the internet and they look pretty good. Nutrition info is listed, so they're easy to track too."
Social Support	Support from others, which can take many forms including	"Haven't seen you log anything in the app lately. We miss you!"

	information, suggestions, or advice.	
Outcome Expectations	Expected outcomes of behaviors.	"I've never really succeeded at a diet before, but I think tracking my calories, weight, and exercise has to help this time around!"

Participants were provided with three, 20-minute, evidence-based weight loss podcasts each week. Podcasts were uploaded to the study website and participants were sent a reminder that a new podcast was available every Monday, Wednesday, and Friday via email. Participants were instructed to listen to three podcasts per week but could listen to the podcasts at a time and place of their choosing. Podcasts were informed by SCT and provided participants with a range of weight loss topics. Podcast topics included: nutrition and exercise information; an audio diary tracking the weight loss progress and challenges experienced by a male and female character; a weight loss soap opera depicting the challenges of overcoming social barriers to weight loss; and a goal setting activity related to weight loss at the end of each episode. Specific information regarding the development and testing of these podcasts in previous interventions can be found elsewhere.[12,27]

Outcome Measures

Participants completed online questionnaires assessing demographic characteristics. Measures of height (SECA 213, using a calibrated stadiometer; baseline assessment only) and weight (SECA 869, Hamburg, Germany, calibrated digital scale accurate to 0.01 kg) were measured at baseline and two-months. Dietary measures were completed by participants using the National Cancer Institute's Automated Self-Administered 24-hour Dietary Recall (ASA24).[28] Each participant completed the ASA24 online for one unannounced weekday and weekend day at baseline and two-months. The following previously validated questionnaires were completed by participants at baseline and two-months, unless otherwise specified: the Paffenbarger Physical Activity Questionnaire to determine calories expended during activity,[29] the 20-item Weight Efficacy-Lifestyle Questionnaire (WEL-Q) to measure participant self-efficacy,[30] the 44-item Big Five Inventory (baseline only) as a measure of personality characteristics,[31] the Sallis Social Support Scale [32] and the Physical Activity Social Influence Scale as measures of social support from family, friends, and online social networks (modified to include online social networks).[33] Objective measures of frequency and duration of app use were collected unobtrusively by a secure network server following the intervention (at two-months). All baseline measurements were collected prior to the administration of the weight loss intervention.

Participants attended one of two focus group sessions at one-month to provide feedback regarding their use of the intervention components (Social POD app and podcasts). The focus groups were conducted by a trained focus group facilitator and questions were asked using a semi-structured interview guide developed by the investigators, including both pre-scripted and spontaneous probes designed to elicit information from participants regarding their experience with the Social POD app. Questions were designed to assess participant satisfaction and dissatisfaction with the weight loss podcasts, the Social POD app including the tracking, prompting, and messaging features as well as the weight graph and history features for future revisions.

Participants were also asked if they would like incentives for using the app, and if so, how they would like an incentive system to be structured. Information regarding aesthetics and appearance of the app was solicited as well.

Focus group sessions were taped using an audio recorder and all participants were instructed to use their study identification number to protect confidentiality during the focus groups. A trained graduate research assistant was present at the focus group sessions to take field notes during the sessions. The focus group facilitator completed detailed memos following each mid-study focus group session to document salient themes from participant discussions. Recordings from the one-month focus group were transcribed verbatim by the trained graduate research assistant and were cross-referenced with recordings for accuracy.

During the study (weeks 1 through 7) participants completed brief weekly online surveys each Friday to report the number of podcasts listened to and the number of days they used the Social POD app during the past week (past 7 days). Participants also reported if they experienced problems using the Social POD app during the past seven days and if they had suggestions to improve the Social POD app. If participants reported problems or suggestions for the Social POD app, they were then asked to write a detailed response.

Statistical Analysis

All qualitative data were collected and analyzed between February and August of 2014 using NVivo for Mac Beta statistical software (QSR International, 2014) to extract a combination of a priori and emergent themes from the focus groups to guide the revision of the Social POD app. Open-ended responses from weekly surveys regarding problems experienced and suggestions for improvements to the Social POD app were coded as well. Stata version 13.1 (StataCorp, 2013) was used to detect statistical significance for all quantitative data analysis. Paired samples *t*-test was used to test for statistically significant differences from pre to post-test for weight, calories consumed, and calories expended during reported physical activity. The effect size for weight loss was also calculated. Correlation between total app entries and percent weight loss at two-months was examined. Correlation between total days of objectively measured app-use and total days of self-reported app-use (via weekly questionnaires) by participants was examined. Fisher's exact test was used, due to the small sample size, to detect significant differences in user-to-user message selection among participants categorized into subgroups based on amount of weight loss (dichotomized into groups of high versus low weight loss at the median split of percent weight loss). The sample size for this study was determined for qualitative analysis based on expert recommendations for mHealth usability testing studies,[34,35] therefore this study was not powered to detect significant changes in within-group weight; however, changes in weight and weight-related behaviors are presented.

Results

A total of 34 individuals inquired about the study, fifteen individuals qualified to participate, and a total of nine completed baseline measures and received the intervention. Major reasons why participants did not qualify included not having an Android phone (n=9, 50%) and meeting medical exclusion criteria (n=3, 17%). Seventy-eight percent of participants (7 of 9 participants) attended the one-month focus group sessions (2 infrequent app users did not attend), and all participants (9 out of 9 participants) completed the post-study questionnaire and unannounced dietary recalls, and had their body weight measured post-study. The response rate for weekly surveys was 62% (39 surveys were completed out of a possible total of 63). Baseline demographics of the study sample (n=9) are presented in Table 2.

Table 4.2: Baseline Demographic Characteristics

Age, mean years (SD)	39 (± 14.5)
Gender, n (%)	
Female	8 (89%)
Male	1 (11%)
Race, n (%)	
Black	3 (33%)
White	6 (67%)
Mean Weight in kg (SD)	91.5 (± 19.1)
Mean Body Mass Index (SD)	35.5 (± 7.1)
Educational Attainment, n (%)	
Advanced	3 (33%)
College	5 (56%)
Some College	1 (11%)
Marital Status, n (%)	
Divorced or separated	1 (11%)
Married	2 (22%)
Single	4 (44%)
Other	2 (22%)

Focus Group Themes

Major themes that emerged during focus group discussions are reported below with illustrative quotes from participants. These themes included Social POD app functionality, improvements to the Social POD app and podcasts, additions to the Social

POD app, incentive and goal system for the Social POD app, and satisfaction with the Social POD app and podcasts.

Functionality of Social POD app

Functionality problems reported by participants included problems with the notification system, which prompted participants to track their daily diet, weight, and minutes of physical activity. Reported functionality issues with the notification system mentioned during the focus groups as well as on the weekly surveys included one failure to receive notifications and one failure of notifications to connect with the correct screen within the Social POD app. Two times the same participant reported spontaneous crashing of the Social POD app on the weekly surveys.

Improvements to Social POD app and Podcasts

Themes relating to suggested improvements for the Social POD app were varied and included adding additional features to the app and modifying existing features of the app. Modifying the color scheme and integrating options for personalization were suggested. One participant suggested using colors that "get your attention more" by replacing the grey and dark blue used in the current version of the Social POD app with brighter colors. Another participant mentioned she would like to have had the opportunity to choose "an avatar or an icon" for her home screen to customize the appearance of her app. Having the ability to track calories consumed on previous dates was another requested modification. Most participants (3 out of 4 participants in this group) reported that the notifications to track their diet, physical activity, and weight were helpful as reminders to track their healthy behaviors, although one participant said she found them to be “annoying.”

There were not many suggested improvements for the podcasts during the focus groups but participants did note problems with sound quality and variation in the volume-level. One participant in the focus groups mentioned that there was a difference in the volume level of the various segments of the podcasts, specifically with the soap opera portion of the podcast. Participants recommended leveling the volume and improving the sound quality of the podcast episodes prior to future use. While all participants reported that they valued the information provided in the podcasts and felt satisfied with the various segments, some participants (n=3) reported they did not like the soap opera portion of the podcast episodes. One participant shared, “I don’t particularly like the soap opera” and two members of the group agreed with this statement as they said this story line was “geared toward young dating women” and “negative.” Another participant said they would have enjoyed the soap opera portion of the podcast more if they could have listened to the episodes consecutively rather than having to wait until the next episode was available to download.

Additions to the Social POD app

Suggested additions to the Social POD app included adding a database of common foods and beverages within the app (versus having to use another app to look-up calorie information) and incorporating an incentive system. Increasing the amount of “praise” provided by the study staff for entering weight and achieving weight loss-related goals was a highly suggested addition to the app. All of the participants that attended the focus groups (n=7) expressed their desire to see how others were doing in the program and to send other participants encouragement for achieving weight loss goals. One participant mentioned it would be interesting to see if messages sent to other users actually motivated them to use the app more frequently. As one participant stated: "I think it'd be interesting to hear somebody from the receiving end to see if that motivated them to do something."

Incentive and Goal System of the Social POD app

All participants in the focus groups reported they would like an incentive system to be rewarded for using the tracking components of the Social POD app. Participants suggested that points should be redeemed for prizes. A participant volunteered, "I'm all about a token economy, so yes, … I think like a five year old, so yeah, that [prizes] really does motivate me."

Participants recommended earning points specifically for completing physical activity, one participant said, "I haven't been nearly as active as I would have liked to have been … having a point reward system for that would be an incentive for me to move more." One Participant mentioned that creating a competition among study participants or giving prizes for "personal bests" would be motivating, this participant said, "I certainly like prizes (laughter). It could also be fun to have a competition between the Social POD users so you could have the leader in points receive some prize or even personal bests, like if you have a 5 week program and your best week you could get some rewards."

Participants recommended the integration of pre-set, or tailored goals, to limit the possibility that some might set unrealistic goals for themselves and "give up" on the program, saying, first Participant: "Think of the other side if you decide for yourself some goals, and for some reason you cannot make them, how would you feel?" Second participant: "Really terrible, but if it was somehow like ... If the system could somehow help you set reasonable goals instead of like high in the sky things that I know I'm not going to do. People do tend to set lofty goals for themselves when really it should be small, measurable, incremental changes at first."

Satisfaction with Social POD app and Podcasts

Themes relating to satisfaction with Social POD app components included the user-to-user messaging system and reported overall satisfaction with the app. Some participants preferred the pre-written user-to-user messages because they seemed more professional than allowing participants to create their own user-to-user messages. A participant volunteered, "I think the pre-populated messages is [are] the best because it's professional."

Overall participants reported satisfaction with the messaging system. Another participant reported that she would have been less likely to send messages to others if she had to write the messages herself. This participant said, "I know that I would be less likely to send a message to someone if I had to write it myself … so having some [messages] to choose from where it takes just a second to do, I'm more likely to do that."

Overall participants reported the Social POD app was "simple" and "easy to use." Participants reported they liked the convenience and ability to use their smartphones to track their diet, which they found to be more inconspicuous than other methods (e.g., using a calorie book). One participant told the group, "Every now and then you feel like James Bond because if you are at the table an[d] you still have your cellphone with you an[d] you turn on the app and … nobody knows what you do… an[d] you just … key in everything an[d] done. I mean it it [at] the end of the day … I've done something for myself today."

Participants also mentioned that the app gave them the motivation they needed to change their diet and physical activity behaviors to lose weight. As one participant stated, "It's definitely been a useful exercise…my thing is process, not perfection … in my case I'm doing a lot more than I was doing before."

All participants in the focus groups volunteered that they valued the information provided in the podcasts. One participant mentioned, "I liked the information…it reinforces what I'm sure most of us already know." Participants reported a variety of methods used to listen to the weekly podcasts. One participant created an icon on their phone to easily access the podcasts and they even set reminders to listen to the podcasts throughout the week, this participant mentioned, "I've set up the podcasts as an icon on my phone. So then I just go to the website and can play it from there, and then I have an alarm set up for Monday, Wednesday, and Friday because otherwise I'll forget to [listen] even with an email I'll probably forget."

Another participant reported they listened to the podcasts from their laptop, they shared with the group, "it's easy, I told you, I listen to this on my laptop, and once I get the email, I just click on the link an my media system in the laptop [and] just open up, and I can see everything there. I wish they could stay. I wished at the end of the study [the podcasts] would not go away."

Participants reported listening to the podcasts in a variety of settings. Some participants reported listening to the podcasts while in the car, one participant mentioned to the group, “I like to listen to it in the car when I’m going to be in the car for twenty or thirty minutes.” Another participant told the group, “I like to listen to them in the car or when I’m getting ready in the morning and that’s a good time to do it, so I appreciate that your assistant sends them early in the morning so I have a good time a whole day really to listen to it.”

All focus group participants mentioned that they liked at least one of the various segments included in the podcast episodes, one participant stated: “I also really like the section where you listen to someone’s diary…that’s helpful.” Another participant shared that they liked the diversity of characters included in the podcasts, they told the group, “I like there’s an array of people who share. Older gentlemen, the women, whoever you seem to identify with you can find somebody who is good for you.”

Suggested Improvements

On the weekly surveys, participants mentioned many of the same suggested improvements discussed in the focus group sessions. Similar suggestions for improvements to the Social POD app included adding more “vibrant” colors to the app, adding customization such as a personal avatar, integrating a nutrient database, having the ability to track diet and activity for previous dates, and providing more “praise for losing weight and/or increasing physical activity.” Additional suggestions made on the weekly surveys not mentioned in the focus groups included adding additional activity options for tracking physical activity (n=1), giving participants the ability to customize the user-to-user messages (n=1), and revising the user-to-user messages to sound more "motivating and encouraging" (n=1).

Planned Revisions of the Social POD app and podcasts Based on Focus Group Themes

A Newsfeed will be developed for the Social POD app for participants to view the progress of other users with weight loss-related goals. Participants will be able to send others encouragement for achieving these goals (e.g., logging 30 minutes of exercise, and logging diet and weight) through the Newsfeed targeting positive reinforcement.[22] Other revisions to the next iteration of the Social POD app will include points tracked on a Point Tracker within the app that will be earned by participants for self-monitoring diet, physical activity, and weight and for sending others encouragement through the Newsfeed. Points will be redeemed for study-provided prizes at the end of the pilot RCT, targeting positive reinforcement.[22] A weight loss competition among participants will not be integrated into the revised version of the Social POD app, as suggested by one participant, to minimize the potential risk of harm to some participants who are not achieving weight loss goals as quickly as others. Integrating a database of food and beverages to view the nutrient content of commonly consumed items, similar to commercial diet tracking apps, was recommended and will be incorporated into the calorie tracking features of the Social POD app to facilitate self-regulation.[23] A more extensive list of activities will be incorporated to the physical activity tracker in the revised Social POD app, also promoting self-regulation.[23] The color scheme of the app will be modified to include colors that are brighter and more eye-catching, and the option to add an avatar on the home screen will be incorporated. User-to-user messages will be revised to include more encouraging statements to better re-engage infrequent users with the Social POD app. Planned revisions for the podcasts include re-recording the podcast episodes to improve the sound quality and volume across segments within the episodes.

Quantitative Results

Participants lost a mean of - 0.94 kg (± 2.22 kg). Differences in mean participant weight before (91.48 kg ± 19.08 kg, 95% CI: 76.82, 106.15) and after (90.55 kg ± 20.01 kg, 95% CI: 75.17, 105.93) the two-month intervention were not statistically significant (p=0.24, d=0.05, r=0.02). Participants reported expending a mean of 171 kcal/day (± 153 kcal/day) during intentional physical activity following the intervention as compared to 138 kcal/day (± 139 kcal/day) at baseline, yet this was not a statistically significant difference (p=0.57). Participants reported consuming significantly fewer calories following the intervention (1570 kcal/day ± 508 kcal/day) than before (2384 kcal/day, ± 993 kcal/day, p=0.01).

Mean number of Social POD app entries over the course of the two-month usability study was 77.2 ± 73.8 (95% CI: 17.66, 133.68) with a minimum of 0 and a maximum of 219 entries. Messages targeting social support were selected and sent most often by frequent users (n=32, 47%), followed by self-efficacy (n=28, 41%), and outcome expectations (n=8, 12%). There was not a statistically significant correlation found between total app entries and percent weight loss over the course of the intervention (r=0.49, p=0.19). There was no difference in the type of message selected (self-efficacy, social support, and outcome expectation) between those participants who were successful at weight loss as compared to those who were less successful (defined at median split in percent weight loss) (p=0.79).

On the weekly surveys, participants reported listening to an average of 2.24 podcast episodes (± 1.50 episodes and a minimum of 0 to a maximum of 6 episodes) per week and they reported using the Social POD app an average of 4.5 days (± 2.25 per week and a minimum of 0 and a maximum of 7). A total of three participants reported problems using the Social POD app a total of seven times over the course of the two-month study. Reported problems from weekly surveys included spontaneous crashing (two times), notifications linking with the incorrect screen in the Social POD app (one time), and there were no responses for the other reported problems on the weekly surveys.

There were two participants with no objective measure of Social POD app use over the course of the study. One participant reported using the Social POD app one day during the study and she specified that she did not use the app on the weekly survey because she did not have enough time. Another participant without objective app use data reported on the weekly surveys that she used the app a total of 21 days during the study. The total number of days participants used the app (as objectively measured by the app) and total number of days of self-reported app use by participants via weekly surveys was highly correlated (r=0.87, p<0.01), indicating that self-report was a reliable measure of app engagement in this study.

Discussion

While there has been much work in the area of mobile app development for health, there is currently little published research in the area of development and testing of new mobile apps for weight loss among adults who are overweight and obese. There are several recent studies documenting the development and testing of new apps for weight loss in adolescents,[36] apps for increasing physical activity and reducing screen time among adolescent males,[37] and apps for predicting the risk of childhood obesity among infants.[38] Several recent studies report on the development and testing of apps for behavior modification of diet and physical activity among the young adult population.[39–41]

In a similar mixed-methods usability study, Morrison and colleagues used a computer-based weight loss program in conjunction with an Android mobile app to improve participant goal setting and motivation to achieve weight management goals among young adult participants over a four-week period.[39] This app also offered participants the opportunity to set notifications, similar to the Social POD app, as reminders to use the diet and physical activity diary features. Participants could choose when and if they would like to receive notifications in an effort to improve the usability and satisfaction with their mobile app.[39] It was found that only about half of the participants used the self-monitoring features of the app over the course of this usability testing.[39] While one participant in the Social POD study noted that the notifications could be "annoying," others found the notifications, which were pre-set by study coordinators, a helpful reminder to self-monitor their behaviors and weight and said that they otherwise would not have performed this task. Prior research has also demonstrated that weight loss is improved when self-monitoring activities are performed in real-time and proximal to the target behavior, [42] indicating that mHealth apps could better help users self-monitor their health-related behaviors using some type of notification system, that cannot be eliminated by participants, throughout the day and at times in which the behavior typically occurs.

In a qualitative study examining the desired features of weight loss apps among young adults, Tang and colleagues found that participants valued the opportunity to move beyond strictly tracking their eating behaviors and wanted a way to integrate other features, such as behavioral weight loss goals.[40] Other mobile apps have also incorporated a goals feature. Morrison and colleagues instructed participants to set their own goals and track their goal achievement progress using their mobile app.[39] In their study, Morrison et al. found that some participants did not set their own goals or monitor their goal-achievement.[39] As some participants are less likely to use app components that require initial set-up (e.g., setting your own goals or notifications), including some type of pre-set behavioral goals for users to achieve could help promote user engagement and motivation with these mHealth apps.

In their qualitative study documenting the development and prototype testing of a smartphone app to promote behavior change to improve eating and activity behaviors to reduce weight gain among young adults, Hebden and colleagues received feedback requesting positive reinforcement for performing desired behaviors (such as eating healthy foods or engaging in physical activity).[41] This is similar to participant suggestions for more opportunities to provide and receive "praise" in the Social POD study. Including opportunities for users to give and receive praise for performing targeted health behaviors could be another necessary component to help establish and maintain health behavior change within the context of mHealth interventions.

The color scheme of the Social POD app will be updated with brighter colors to better appeal to users, as suggested in the Social POD participant focus groups. Tang and colleagues conducted focus groups with young adult participants and also found that the perceived attractiveness of an app was an important consideration for participant satisfaction and maintaining engagement with weight loss apps.[40] Similar functionality issues, as with the notification system of the Social POD app, were found in a study conducted by Morrison and colleagues where a participant reported not receiving notifications during their testing of a new mobile app for goal setting and self-monitoring of diet and activity among a small sample of adults.[39] Ensuring that all components of mHealth apps are functioning properly over time is of great importance in remotely delivered behavioral health interventions and an integral part of the usability testing process. Following usability testing, it was imperative to prioritize the changes that were made to the Social POD app prior to the pilot RCT. Correcting functionality issues as well as the development of the newsfeed and incentive systems took priority over the incorporation of a nutrient database and changing the color scheme to make the app more visually appealing. Ultimately there was not enough time to incorporate as extensive of a nutrient database as hoped and the developer was not able to incorporate avatars so that users could personality the Social POD app.

Limitations

There are several limitations with this current study. As the purpose of this study was to test the first iteration of the Social POD app prior to the pilot RCT, this study was not adequately powered to detect statistically significant differences in pre-post scores. The time period of the study was also very short and may have been too short to detect significant differences in participant pre-post body weight after just two months. While weight and height were objectively measured, participant self-report was used when measuring calories consumed on the ASA 24-hour dietary recall and calories expended during activity on the Paffenbarger Physical Activity Questionnaire (versus an objective measure of physical activity). The Social POD app is currently only available for the Android operating system. Despite the fact that the Android phone is the most prevalent cell phone in the U.S.,[43] the fact that other smartphone users (such as iPhone users) were excluded may reduce the generalizability of the findings. Direct questioning (versus open-ended questioning) was used to solicit participants' opinions regarding the addition of an incentive system, which could have resulted in bias. The sample size of this study was also very small, at just nine participants and only one male, and was therefore not a representative sample of all potential users of the Social POD app. As the sample size was small, the message selection results could be skewed towards the message-type that frequent participants preferred and therefore not representative of the entire sample of this study. Participants were instructed to use a commercial database to identify the caloric content of food and beverages consumed and use of this database could have contributed to the change in weight observed following this intervention.

Strengths

One strength of this study was the use of a mixed-methods design, which included participant focus groups to obtain feedback regarding the usability, functionality, and suggestions for improvements to the Social POD app prior to the pilot RCT. Obtaining feedback through the weekly surveys is another strength, given the potential for some participants to refrain or modify comments during focus groups based on social desirability bias. Another strength of this study is the iterative testing of the Social POD app to uncover and resolve functionality issues prior to the pilot RCT.[34] The use of theory-based messages that can be selected and sent to infrequent users to help potentially re-engage them with this weight loss intervention is another strength. The remote delivery of this weight loss intervention is another strength, as remote interventions are typically more convenient, less costly, and less burdensome for participants than traditional (clinic-based) interventions.[7] The use of a mobile app for tracking diet, physical activity, and weight is also a strength, as previous research has shown greater participant adherence over time with this method versus a paper or computer-based method (i.e., website).[44] While the total number of app entries was not statistically significantly correlated with percent weight loss, a correlation coefficient of r =0.49 represents a fairly large effect size.[45] Furthermore, mean difference in calories expended during intentional physical activity from pre- to post-test was also not significantly different, however this represented a small effect and could be greater if tested among a larger sample and over a longer time period.[45] While the sample size was small in this usability study, the minimum percentage of problems identified during testing of mobile apps increased from 55% to 85% when the sample size increased from 5 participants to 10, respectively.[46] The reach of mHealth interventions, such as this, has the potential to be even greater than traditional face-to-face interventions even small changes in weight have the potential to impact public health outcomes and reduce disease risk.[47] As little as a one kilogram reduction in body weight, as seen in this study, has been associated with a 16% reduction in Type 2 diabetes risk [48] demonstrating that this type of mHealth intervention is a scalable way to deliver a weight loss program with beneficial reduction of disease risk. The comparison of objective and subjective reports of app use is another strength of this study.

Conclusion

The Social POD app provides an innovative way to encourage self-monitoring of dietary intake, weight, and physical activity while encouraging frequent users to provide social support to infrequent users. While there is time needed upfront to develop the intervention, this mHealth intervention can be disseminated broadly for many years and to many individuals without the need for additional intensive in-person hours. The Social POD app should be tested in a larger clinical trial for a greater length of time to determine if changes in participant weight, calories consumed, calories expended during physical activity are improved by this entirely mobile-based weight loss intervention.

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Conflict of Interest

The authors do not have any conflicts of interest to report.

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4.2: Social Networks for Improving Healthy Weight Loss Behaviors for Overweight and Obese Adults: A Randomized Clinical Trial Using a Mobile App[2]

[2] Hales, S., Turner-McGrievy, G.M., Wilcox, S., Davis, R.E., Fahim, A., Huhns, M., and Valafar, H. To be submitted to *American Journal of Preventive Medicine.*

Abstract

Introduction: The purpose of this study was to test the efficacy of a mobile app developed to target social support and self-monitoring of diet, physical activity (PA), and weight (Social POD), compared to a commercially available diet and PA tracking app (standard).

Main Outcome: Weight loss (kg) at 12 weeks.

Methods: Overweight adults [N=51] from two cities in South Carolina were recruited and randomly assigned to either the experimental group [n= 26; theory-based podcasts (TBP) + Social POD app] or comparison group (n=25; TBP + standard app) in 2015. The Social POD app issued notifications to encourage users to self-monitor and send pre-written messages to support users who had not self-monitored in the previous 48 hours. It was hypothesized that participants in the experimental group would lose significantly more weight than those in the comparison group. Independent samples *t*-test was used to examine group differences in kilograms lost and change in BMI. Both complete cases and intent-to-treat analysis with baseline observations carried forward (BOCF) were computed for the main outcome. Analysis of covariance was used to analyze secondary outcomes while controlling for baseline values.

Results: Participant attrition was 12% (n=3 experimental and n=3 comparison). Experimental group participants lost significantly more weight (-5.3kg, CI: -7.5, -3.0) than comparison group participants (-2.23kg, CI: -3.6, -1.0; p=0.02) and had a greater reduction in BMI (p=0.02). These outcomes were significant for both BOCF and complete case. While there were significant differences in positive outcome expectations

between groups (p=0.04) other secondary outcomes (e.g., caloric intake and social support) were not significant.

Conclusion: Use of the Social POD app led to greater weight loss than a standard diet tracking app. This mobile health intervention has the potential to be widely disseminated to reduce the risk of chronic disease associated with overweight and obesity.

Clinical trial registration number: NCT02344836

Introduction

Rates of overweight and obesity remain high at 71% of U.S. adults meeting this criteria (Body Mass Index (BMI) >25 kg/m^2).[1] Behavioral interventions that target improvements in diet and physical activity (PA) are an effective method to help people lose weight, maintain weight loss, and decrease chronic disease risk.[2] Mobile health (mHealth), the use of mobile devices (including smartphones, tablets, and others) to improve health-related behaviors and assist with disease management, is an emerging mode of conducting behavioral research.[3–6] The majority (64%) of adults in the U.S. own a smartphone,[7] and smartphone ownership is pervasive across various ethnic groups.[8] Benefits of mHealth interventions include reduced intervention implementation time and participant burden[9] and an ability to reach a broad and diverse population. In previously delivered remote weight loss interventions, frequent self-monitoring of diet, PA, and weight;[10,11] social media use;[5,12,13] improvements in perceived social support and self-efficacy for health behaviors,[14] and positive outcome expectations of treatment[14] have been shown to promote weight loss.

While the marketplace contains many apps targeting diet and PA, most have not been developed by experts in health promotion using evidence-based strategies and sound behavioral theories.[15–17] In addition, most of these currently available apps have not been rigorously tested to assess efficacy and weight loss outcomes among overweight and obese users.[15] The purpose of this study was to test the efficacy of a mobile app developed by researchers targeting social support and self-monitoring of diet, PA, and weight among overweight and obese adults (BMI 25-49.9 kg/m2) compared to a commercially available tracking app. The main outcome was weight loss (kg) at 12 weeks. Secondary outcomes included group differences in BMI, caloric intake and expenditure, and social support for diet and exercise behaviors, self-efficacy for weight loss behaviors, and outcome expectations of treatment.

Methods

Participant Recruitment and Intervention Implementation

Sample size determination for this study was based on mean percent weight loss and standard deviation at three months from a prior study utilizing the same podcasts as this intervention and a commercial diet and fitness tracking app.[5] Based on an anticipated weight loss of 5% (experimental group), an effect size between 0.52 and 0.64 (significance at α=0.05 and power 1-β=80%), a mean difference between groups of 2.4% body weight loss, and a pooled SD between 3.5 and 5.5%, a sample size of 31-47 participants per group would be needed plus 10% attrition (34 – 52 per group).

Overweight and obese adults from two mid-size cities in South Carolina with Android smartphones and tablets were recruited for a three-month weight loss intervention. Participants were recruited via university and worksite listserv announcements, community and worksite flyers, newspaper advertisements, university and worksite electronic newsletters, social media posts, handouts at a local research fair, and word of mouth.

Exclusion criteria included not having an Android device, BMI outside the range of 25.0-49.9 kg/m^2, unable to attend required measurement sessions, unable to access a computer or internet for completing assessments, having a psychiatric illness, receiving treatment for drug or alcohol dependency, having an eating disorder, participating in another weight loss program, reporting weight loss of ten pounds or more in the past six months, being pregnant or planning on becoming pregnant during the study, or breastfeeding. Exclusion criteria also included endorsing items on the PA Readiness Questionnaire (PAR-Q) regarding having a heart condition, feeling chest pain during physical activity, experiencing chest pain, and becoming dizzy or ever losing balance or consciousness.[18] If participants reported joint problems or taking blood pressure medication, they were required to have physician consent to participate in the study. Participants received a total of $10 for completion of all assessments (both baseline and three-months). No persons were excluded from participation due to race, ethnicity, or gender.

Interested participants were directed to a study website, where they completed an online screening form to determine eligibility. Participants who qualified for the study were contacted by the study coordinator, who reviewed all information provided on the online screener and invited the participant to an orientation session to learn more about the study. At the orientation session, participants were given a detailed description of the study, provided informed consent, and received a study identification number and password and instructions for completing their questionnaires online. Participants were instructed to return in two weeks for a training session. This study was approved and monitored by the University of South Carolina Institutional Review Board.

Prior to the training session, participants completed computer-administered baseline assessments at a location of their choosing. Participants completed one unannounced (1 weekday and 1 weekend) dietary recalls at baseline and again at three months using the National Cancer Institute's Automated Self-Administered 24-hour Dietary Recall (ASA24).[19] The following previously validated questionnaires were completed by participants at baseline and three months, unless otherwise specified: Paffenbarger PA Questionnaire (assessing calories expended during PA),[20] the Stanford Expectations of Treatment Scale[21] (assessing negative and positive outcome expectations of treatment), the Weight Efficacy-Lifestyle Questionnaire[22] (assessing self-efficacy to resist eating in specific situations), the Sallis Social Support Scale[23] (assessing diet and PA social support), and the PA Social Influence Scale (assessing social support and participation from family and friends).[24] In addition, questions assessing support from online social networks were added to this social support measure.[24] Demographics, including participants' history of downloading and using podcasts, diet tracking apps, and PA tracking apps, were assessed at baseline. An item on the final survey asked participants to rate their level of agreement, using Likert scale responses (1=complete disagree to 7=complete agree), with the statement that they were satisfied with the overall intervention they received.

Participants who completed the baseline survey and dietary recalls were randomized to study groups by the study coordinator using Randomizer.org[25] to generate a list of random numbers between one (experimental) and two (comparison) and were given a choice of study assignment-specific training sessions to attend. Participants were not informed of their group assignment until after they arrived at the training session and had their baseline weight and height measurements assessed.

At the training sessions, participants received instructions regarding how to access the podcasts, download and use their assigned apps, and complete weekly questionnaires. Baseline measures of height (SECA 213, using a calibrated stadiometer; baseline assessment only) and weight (SECA 869, Hamburg, Germany, calibrated digital scale accurate to 0.01 kg) were obtained by trained study staff. Participants downloaded their respective tracking apps [experimental used the Social POD app and comparison used the Calorie Counter by Fat Secret app, (© 2015 Fat Secret)] at the training session. All participants were instructed to track their total calories from all meals, snacks, and beverages consumed; minutes of intentional PA; and body weight each day for the duration of the study using their tracking apps. Participants also received two theory-based podcasts (TBP) sent via email each Tuesday and Thursday morning (total of 24). To access podcasts, participants selected a link from the email message and entered their study identification number and initials, which allowed for objective tracking of podcast access. Specific information regarding podcast development and testing in previous interventions can be found elsewhere.[4,5] Briefly, podcast topics included: behavioral strategies to improve nutrition and PA behaviors with a focus on achieving a healthy weight; an audio diary tracking the weight loss progress and challenges experienced by a male and female character; a weight loss soap opera depicting the challenges of overcoming social barriers to weight loss; and a goal setting activity related to healthy behaviors that promote weight loss at the end of each episode. Table 1 presents the intervention components and the theoretical constructs targeted.

Both groups received the intervention from February to May of 2015. Participants completed weekly surveys online sent via email assessing their use of the podcasts and tracking apps. The weekly surveys asked participants from both groups to report the total number of days (out of the past 7 days) that they used their tracking apps (including viewing something in the app and logging information) and how many podcasts they listened to that week. At 6 weeks, the study coordinator reviewed all weekly surveys to monitor for non-compliance with podcasts and tracking apps. If a participant did not complete these surveys or indicated non-compliance with the intervention, the coordinator contacted the participant to trouble-shoot any technical issues. At the final meeting, weight measures were obtained, as well as objective measures of app use for the previous three days prior to the final meetings by having study staff view and record each diet entry (out of a possible 3 meals and 1 snack per day) from each participant's tracking app used during the study. A description of the tracking apps used by each group follows and can be seen in Table 1.

Comparison Group app

Features of the standard tracking app (Calorie Counter by Fat Secret) included: 1) searchable calorie database; 2) PA database; 3) weight tracker with a graph; 4) recipe index; 5) periodic email reminders to weigh-in; and 6) journaling feature.

Experimental Group app

Similar to the standard tracking app, the Social POD app included diet, PA, and weight tracking features and a calorie database with commonly consumed food and beverages. If participants from the experimental group were unable to find a specific food or beverage in the calorie database, they were instructed to consult the standard app nutrient database as an additional resource for nutrient information. Within-app notifications at specific times throughout the day were sent to participants to remind them to self-monitor meals (breakfast at 9:00am, lunch at 1:00pm, dinner at 8:00pm), minutes of PA completed (9:00pm), and total body weight (8:00am) each day. A notes feature allowed participants to enter notes relating to their weight loss in the app.

The Social POD app utilized theory-based messages designed by the interventionists to help re-engage infrequent participants over the course of the two-month study. User-to-user messages were created using Social Cognitive Theory (SCT)[26,27] to target social support,[13] self-efficacy,[26,27] and outcome expectations[28] regarding self-monitoring behavior (i.e., targeting self-regulation)[27] of diet, PA, and weight. Constructs from SCT were selected for this study based on results from a previous internet-based weight loss intervention, which found that targeting these specific constructs led to healthier diet and PA behaviors and resulted in a significant reduction of participant body weight.[14]

Participants who were regularly using the Social POD app (defined as having logged anything within the previous 48 hours) were prompted, via notifications, to send encouraging messages to other group members who did not enter data in the app during the previous 48 hours (infrequent users). Researchers selected this model of matching participants to provide support based on recommender systems utilized in applications that filter information to make recommendations and match users (such as online dating sites) based on user history or stated preferences.[29] Self-efficacy messages were designed to incorporate informational social support with suggestion, advice, referral, and teaching sub-types (example "Even though it was hard to figure out how many calories I was eating at first, I found out I can do it pretty easily now. I just take it one day at a time."). Social support messages were designed to provide specific types of emotional support including the sub-types of social support such as encouragement, empathy, and sympathy as well as network support and companionship and esteem support relief from blame and compliments[13] (example: "Haven't seen you log anything in the app lately. We miss you!"). Outcome expectations messages were designed to provide examples of positive outcomes of healthy behaviors related to diet, PA, and weight self-monitoring as well as reframing negative thoughts about healthy behaviors[28] (example: "I'm excited to be focusing on a healthy diet! It's a lot better than all those fad diets out there.").

The Social POD app also included an incentive system including a goals page, newsfeed, and point tracker. Goals for using the Social POD app for tracking diet, PA, and weight and for sending encouragement to others in the study were listed on the goals page of the app. A newsfeed was developed for participants to view the progress of other users with weight loss-related goals, with the ability to send others encouragement ("stars") for achieving these goals (e.g., logging 30 minutes of exercise, and logging diet and weight). A point tracker allowed participants to view the number of points that they earned for self-monitoring diet, PA, and weight and sending others encouragement through the newsfeed. Participants could earn up to 4 points each day for a total of 336 points over the course of the study. Points could be redeemed for study-provided prizes at the final assessment meeting.

Statistical Analysis

All variables were tested for normality. Independent samples *t*-test was used to examine differences in demographic characteristics between the two groups, using chi-square test for categorical outcomes. Independent samples *t*-test was used for the main outcome of between group differences in kilograms lost at 3 months as well as the secondary outcome of change in BMI. As a sensitivity analysis, both intent-to-treat analysis with baseline observation carried forward (BOCF) and complete cases were assessed for the main outcome of kilograms lost at three months. As results from both analyses were statistically significant, results from complete case analyses are reported to reduce potential bias resulting from imputing missing outcome observations.[30] Psychosocial variables violated assumptions of normality so analysis of covariance (ANCOVA) was used. Separate ANCOVA models were used to examine group differences in final measures (as the dependent variable), with group assignment as the independent variable and baseline measures as covariates for secondary outcomes including: caloric intake, caloric expenditure (kcals/week), social support, self-efficacy, and outcome expectation scores. Means and standard deviations were computed for secondary outcomes, objective measures of surveys completed, podcast use, and app use using independent samples *t*-tests. A frequency distribution was used to determine how many messages of each type were sent to infrequent users during the intervention.

All data were analyzed using Stata version 13.1 (StataCorp, 2013) to detect statistical significance.

Results

A total of 189 individuals inquired about the study, 62 individuals attended the orientation session, 51 participants were randomized, and 42 completed final weight measurements. Three participants' final weight measurements were excluded from the analysis of main outcomes (experimental: n=1 due to reported contraindicated medication, n=1 due to reported knee surgery; comparison: n=1 due to reported pregnancy). The most common exclusion criteria among those who inquired about the study was a history of an excluding medical condition (19%), followed by not having an Android smartphone or tablet (16%), and providing incomplete contact information on the online survey (16%) (Figure 1). Participants were mostly White (57%) females (82%) with a mean BMI of 34.7 ±6.0 kg/m^2 and mean age of 46.2 ± 12.4 years (Table 2). There were no significant between-group differences in any baseline characteristics with the exception of prior history of downloading a diet app, with more comparison group participants reporting downloading an app to track their diet than experimental participants.

Main Outcomes

Participant attrition for the main outcome was 12% (n=3 experimental, n=3 comparison, out of 51 participants who began the study). Results are reported as mean and 95% Confidence Intervals (CI). Experimental group participants lost significantly more weight (-5.3 kg, 95% CI: -7.5, -3.0) than comparison group participants (-2.2 kg, 95% CI: -3.6, -1.0) for complete cases (p=0.02). BOCF analysis yielded similar results (p=0.03); therefore, complete case analyses are reported.

Secondary Outcomes

Experimental group participants had a significantly greater reduction in BMI (mean -1.9 kg/m^2, 95% CI: -2.6, -1.2) than comparison group participants (mean -0.9 kg/m^2, 95% CI: -1.4, -0.5, p=0.02). There were no significant differences in final reported caloric intake [F (2,1)=0.17, p=0.68] or final reported caloric expenditure [F (2,1)=0.00, p=0.97] by group assignment, with both groups reducing caloric intake and increasing caloric expenditure during PA following the intervention.

There were no significant group differences for any of the final psychosocial variable scores, with the exception of positive expectations of treatment (Table 3). Comparison group participants reported a significantly greater decrease in positive expectations than experimental participants [(F 2,1)=4.46, p=0.04].

Process Outcomes

The total number of weekly surveys (out of 12) completed between groups was not significantly different [experimental 8.3±3.4 surveys (95% CI: 6.90, 9.76), comparison 7.8±3.8 (95% CI: 6.2, 9.5); p=0.63)]. On the weekly surveys, average total days of reported app use (out of a possible 84 days in the study) was significantly greater for the experimental group (50.7± 25.0 days (95% CI: 40.1, 61.2), than the comparison group [34.4± 25.8 days (95% CI: 23.3, 45.6); p=0.03)]. Over the past three days prior to the final sessions, the two groups did not significantly differ in mean number of meals tracked for this period (experimental 4.9±4.3 meals, comparison 4.4±4.7 meals; p=0.68).

Objective number of podcasts downloaded did not significantly differ between groups [experimental 20.9±13.5 podcasts (95% CI: 14.9, 26.9), comparison 16.5±10.3 podcasts (95% CI: 12.2, 20.8); p=0.22)]. There were no significant differences for reported satisfaction with the intervention on the final survey [experimental 6.0±1.8 (out of 7.0), comparison 5.0±2.1; p=0.14]. Users of the Social POD app sent mostly social support messages (n=119 messages, 37.78%), followed by outcome expectations (n=99, 31.43%), and self-efficacy messages (n=97, 30.79%).

Discussion

Use of a weight loss behavioral self-monitoring app developed by experts in health behavior and computer science resulted in significantly greater weight loss than use of a commercially available tracking app when both were combined with TBPs targeting constructs from SCT. In the initial RCT of the TBPs utilized in this intervention, mean weight loss at three-months was -2.9 kg.[4] In the subsequent RCT, mean three-month weight loss for the control group (TBP) was -2.6 kg as compared to -2.6 kg in the experimental group (TBP + standard mobile tracking app + social support delivered via Twitter).[5] In the present study, comparison group participants had similar weight loss observed in previous studies using TBPs plus self-monitoring (-2.2 kg); however, the experimental group (TBP + Social POD app) saw weight loss (-5.3 kg) that was double what has been observed in the previous studies. This suggests that the Social POD app was potentially more successful at encouraging self-monitoring and providing social support than previous interventions using TBP alone or TBP plus commercial diet app and social networking site.

The present study also found that there were significant differences in engagement with the mobile app technology with experimental participants reporting using the app more often than the comparison group, which could explain the differential weight loss outcomes. Another remotely delivered weight loss intervention found that adherence to a self-monitoring intervention for weight loss, regardless of the method used for self-monitoring, resulted in greater weight loss and long-term weight maintenance.[10] Similar podcast utilization between groups suggests that there were components of the Social POD app that were driving the differences in observed weight loss between groups. Since maintaining participant engagement over time in mobile interventions is a challenge,[31] it is significant that participants reported using the Social POD app more frequently than those using a commercially available tracking app. The more proximal data entry is to the actual behavior, the more likely the behavior will be reinforced.[10] Regular prompts to self-monitor from the Social POD app could have contributed to more frequent real-time data entry, thereby resulting in reinforcement and significantly greater weight loss outcomes among participants in the experimental group.[10] The addition of earning points exchanged for prizes tied to goals related to self-monitoring could have also differentially impacted experimental group participants' reinforcement to self-monitor using the Social POD app throughout the intervention.[26]

Neither group experienced significant changes in social support and self-efficacy for diet and PA behaviors or changes in negative treatment expectations at final measurements. Significant group differences might not have been detected for psychosocial variables given that both groups received the same TBPs, which targeted all three psychosocial variables. In a prior web-based study for weight loss conducted by

Anderson-Bill and colleagues targeting the same psychosocial variables as this study, significant between-group differences in change scores were detected, but follow-up occurred at six months (as opposed to three-months).[14] Similar to the Social POD study, another mobile-based weight loss intervention also failed to see significant between or within group differences in these psychosocial variables within a similar time frame.[4] However, the previously referred study did find that information processing variables, such as elaboration and cognitive load, mediated the effect between use of TBP and weight loss.[32] Given that there were no significant differences in psychosocial behavioral outcomes related to weight loss by group assignment, it is possible that additional features that engaged, prompted, and motivated participants to use the Social POD app more frequently were responsible for the differential weight loss observed among the two groups. While health behavior theory was useful in designing the Social POD app, changes in these outcomes might not be what drove the changes in health behavior. Future research should examine which components of the Social POD app were associated with weight loss. The groups also differed in positive expectations following the intervention, which could be a result of comparison group participants receiving less encouragement and extrinsic motivation from use of their tracking app than experimental participants.

While there has been some work recently in the area of mobile app development for weight loss among various populations,[33–36] there is currently little published research in the area of development and testing of new mobile apps for weight loss among overweight and obese adults.[37] This study ads to current literature around using mHealth to target adult obesity in several ways. First, this study tested the Social POD app, which was used to test theoretical constructs and can be incorporated into different platforms and media as technology evolves, as compared to a current commercial technology. A prior mHealth study also found that an app developed for research was effective for weight loss but was compared to an attention control group.[34] In addition our study involved no in-person meetings with the exception of assessments. A prior mHealth intervention found similar weight loss outcomes for overweight and obese adults at three months (-5.2 kg) but utilized in-person sessions.[38]

There are several limitations with this current study. The study had a short duration. Future research should see if Social POD could assist with weight loss maintenance. Participant self-report was used when measuring calories consumed and calories expended and these measurements could be subject to potential recall bias. The Social POD app was only available for the Android operating system. Despite the fact that the Android phone is the most prevalent cell phone utilized in the U.S.,[39] the fact that other smartphone users (such as iPhone users) and non-smartphone users were excluded may reduce the generalizability of the findings. Neither research staff nor participants were blinded to group assignment and the sample size of the study was small which could limit generalizability of the results.

There are several strengths of this study. First, the randomized design was a strength, including the use of an equivalent comparison group. This remotely-delivered intervention was less time-intensive for research staff and participants than many face-to-face interventions and could easily be scaled-up to reach a much larger population using fewer resources than are typically required by traditional face-to-face approaches. In addition, this study was conducted with a diverse population with 39% of participants being African American. This represents one of the most diverse mHealth weight loss interventions among adults conducted to date.[40]

Conclusion

The Social POD app holds promise as a successful way to provide social support during behavior change and to encourage self-monitoring of dietary intake, weight, and PA, resulting in significant and clinically meaningful weight loss. This approach that used a recommender system to connect users to provide social support to one another; incentivized self-monitoring through a point system; and prompted participants to self-monitor throughout the day, demonstrates that these may be key features to add to mHealth interventions for adult weight loss. This mHealth intervention has the potential to be widely disseminated to help overweight and obese adults lose weight and reduce their risk of developing chronic diseases. This intervention was successful with little in-person contact from study counselors, increasing the potential success of scaling-up this type of intervention in the future.

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Contributions

GTM, MH, HV, SW conceived the project. MH, HV, and AF contributed to the programming of the Social POD app. Data acquisition and interpretation were conducted by GTM and SH. SH performed the statistical analyses. SH wrote the manuscript, and all authors were responsible for the research concept and design as well as critical revision of the manuscript, and approved the final version.

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Figure Titles, and Tables

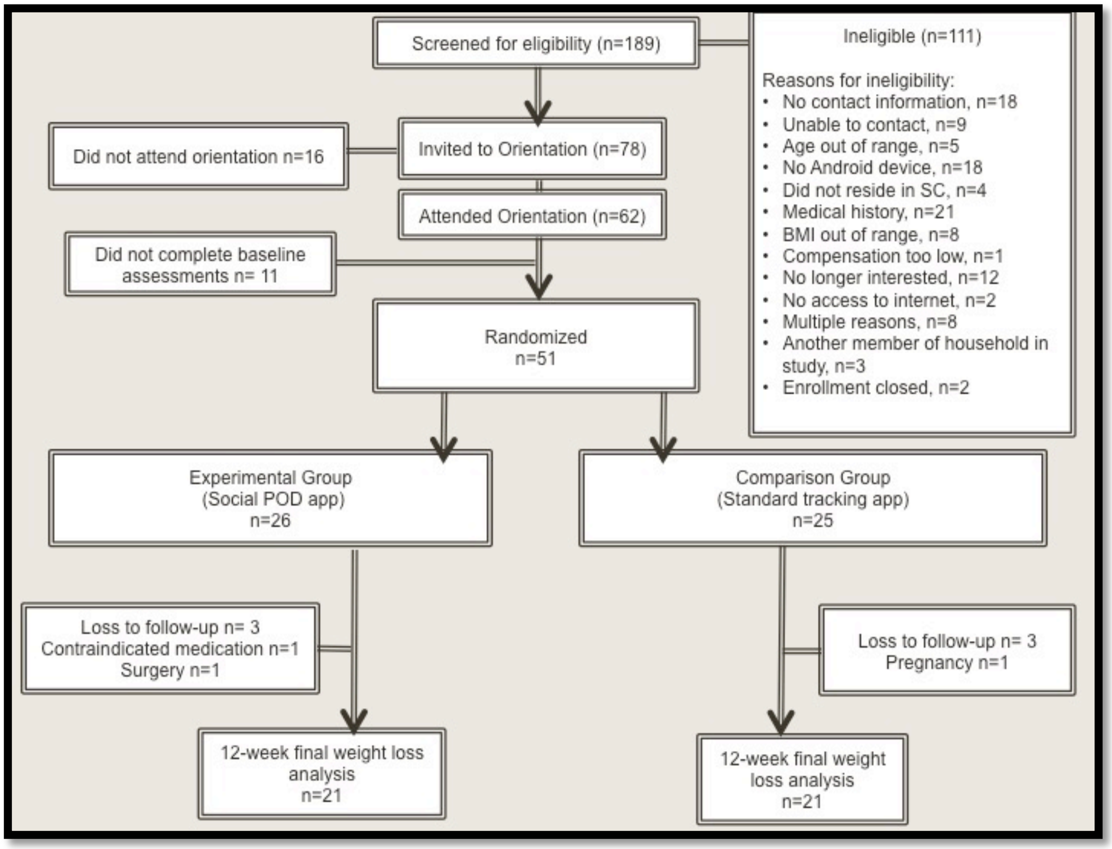

Figure 4.3: CONSORT Diagram

Table 4.3: Theoretical constructs addressed by intervention components

Intervention Component	**Theory**	**Construct**	**Study Group**	
			Social POD - Experimental	**Fat Secret - Comparison**
Nutrition and exercise information presented in podcasts	Social Cognitive Theory	Outcome expectations and behavioral capability	X	X
Podcast audio diary	Social Cognitive Theory	Outcome expectations, self-efficacy, and social support with informational, network, and emotional support subtypes	X	X
Podcast weight loss goal	Social Cognitive Theory	Self-efficacy and self-regulation	X	X
Diet, PA, and weight tracking app components	Social Cognitive Theory	Self-regulation	X	X
App notifications at specific times to remind participants to use tracking components	Social Cognitive Theory	Self-regulation	X	
Stars sent by users through the newsfeed to other users for achieving goals.	Social Cognitive Theory	Social support with encouragement subtype.	X	
Within-app user-to-user messages	Social Cognitive Theory	Self-efficacy and outcome expectations	X	
	Ecological Perspective–Interpersonal Level	Social support with informational, network, and emotional support subtypes.		
Incentive system including goals, newsfeed, and point tracker	Social Cognitive Theory	Reinforcement	X	

Table 4.4: Baseline Demographic Characteristics and History of Technology Use (N=51)

	Experimental Group (n=26)	**Comparison Group (n=25)**
Age, mean years (SD)	48.4 (± 11.9)	43.9 (± 12.7)
Gender, n (%)		
Female	22 (85%)	20 (80%)
Male	4 (15%)	5 (20%)
Race, n (%)		
Black	10 (38%)	10 (40%)
White	15 (58%)	14 (56%)
Other	1 (4%)	1 (4%)
Mean Body Mass Index (kg/m^2) (SD)	36.2 (± 6.3)	33.2 (± 5.3)
Educational Attainment, n (%)		
Some college	3 (12%)	2 (8%)
College	13 (50%)	15 (60%)
Advanced Degree	10 (38%)	8 (32%)
Employment Status, n (%)		
Student	2 (8%)	2 (8%)
Part-time	1 (4%)	0 (0%)
Full-time	21 (80%)	20 (80%)
Retired	0 (0%)	2 (8%)
Out of work	0 (0%)	0 (0%)
Other	2 (8%)	1 (4%)
Marital Status, n (%)		
Married	9 (35%)	12 (48%)
Divorced	4 (15%)	3 (12%)
Living with partner	2 (8%)	2 (8%)
Never married	10 (38%)	6 (24%)
Separated	1 (4%)	2 (8%)
Ever downloaded a podcast, n (%)		
Yes	9 (35%)	13 (52%)
No	16 (61%)	11 (44%)
Do not know	1 (4%)	1 (4%)
Ever installed a diet-tracking app, n (%)*		
Yes	**8 (31%)**	**19 (76%)**
No	**18 (69%)**	**6 (24%)**
Ever installed a PA tracking app, n (%)**		
Yes	12 (48%)	14 (56%)
No	13 (52%)	11 (44%)

* Boldface indicates statistical significant between group difference (p=0.001).

** Failed to answer this question (n=1, Experimental Group)

Table 4.5: Baseline to 3-month Changes in Weight, Calories, and Psychosocial Characteristics

Outcome variable and group	**Assessment Period [a, b]**		***P*-value [c]**
	Baseline	**3-months**	
Weight (kg)			
Experimental (n=21)	102.1 (91.9, 112.2)	96.8 (87.3, 106.2) **Weight loss (kg):** -5.3 (-7.5, -3.0)	**0.02[d]**
Comparison (n=21)	92.0 (82.6, 101.4)	89.7 (80.0, 99.3) **Weight loss (kg):** -2.2 (-3.6, -1.0)	
BMI (kg/m^2)			
Experimental (n=21)	36.4 (33.3, 39.5)	34.5 (31.5, 37.5) **BMI reduction:** -1.91 (-2.6, -1.2)	**0.02[d]**
Comparison (n=21)	33.3 (30.8, 35.7)	32.4 (29.8, 34.9) **BMI reduction:** -0.90 (-1.4, -.45)	
Calories Consumed (kcals/day)			
Experimental (n=22)	2006.5 (1701.4, 2311.6)	1616.1 (1328.6, 1903.5)	0.68
Comparison (n=21)	2336.2 (1970.5, 2701.8)	1794.2 (1503.8, 2084.6)	
Calories Expended (kcals/week)			
Experimental (n=22)	591.6 (342.4, 840.7)	1667.9 (823.0, 2512.7)	0.97
Comparison (n=21)	648.1 (273.7, 1022.6)	1673.1 (1059.5, 2286.8)	
Social Support Scale for Diet and Exercise Behaviors [g]			
Encouragement [e] (15 min – 75 max)			
Experimental (n=22)	23.7 (19.6, 27.9)	28.6 (24.5, 32.8)	0.28
Comparison (n=21)	20.0 (17.2, 22.7)	24.1 (20.2, 28.1)	
Discouragement [e] (15 min – 75 max)			
Experimental (n=22)	28.5 (24.7, 32.2)	28.6 (23.7, 33.5)	0.49
Comparison (n=21)	28.6 (24.3, 32.7)	26.9 (22.7, 31.0)	
Participation from Family [e] (10 min – 50 max)			
Experimental (n=22)	20.2 (15.9, 24.6)	21.5 (16.8, 26.1)	0.10
Comparison (n=21)	19.0 (14.5, 23.5)	16.7 (12.2, 21.2)	
Participation from Friends [e] (10 min – 50 max)			
Experimental (n=22)	21.7 (16.6, 26.8)	20.2 (15.5, 24.9)	0.98
Comparison (n=21)	18.5 (14.7, 22.3)	18.0 (12.2, 23.7)	
Participation from Online Social Network			

[e,f] (10 min – 50 max)			
Experimental (n=22)	12.1 (10.2, 14.0)	11.9 (10.1, 13.7)	0.09
Comparison (n=21)	10.7 (9.8, 11.5)	10.1 (8.7, 11.6)	
Weight Efficacy and Lifestyle Questionnaire (WEL-Q)			
Self-efficacy (20 min -180 max score)			
Experimental (n=22)	116.7 (104.2, 128.9)	126.4 (109.7, 143.2)	0.49
Comparison (n=21)	111.4 (94.8, 127.9)	116.1 (98.0, 134.2)	
The Stanford Expectations of Treatment Scale			
Positive Expectations (1 min - 7 max score)			
Experimental (n=22)	4.62 (4.2, 5.1)	4.56 (4.1, 5.0)	**0.04**
Comparison (n=21)	4.30 (3.9, 4.7)	3.73 (3.1, 4.4)	
Negative Expectations (1 min - 7 max score)			
Experimental (n=22)	5.82 (3.9, 7.8)	1.65 (1.2, 2.1)	0.40
Comparison (n=21)	6.62 (4.7, 8.5)	1.94 (1.4, 2.5)	

[a] All values are mean; 95% CIs in parentheses, unless otherwise specified
[b] Boldface indicates statistical significance for group difference at p<0.05
[c] *P*-values reported for group differences from ANCOVA models, unless otherwise specified
[d] *P*-values reported for between group differences from independent samples *t*-test
[e] Sub-scales of social support for diet and physical activity behaviors
[f] Sub-scale of social support adapted by authors as a measure of participation from online social network members in diet and physical activity behaviors.
[g] Scale was adapted to also include participation from an online social network

4.3: TRADING POINTS FOR POINTS: ENGAGEMENT AND WEIGHT LOSS IN A MOBILE INTERVENTION[3]

[3] Hales, S., McGreivy, T.M., Fahim, A., Wilcox, S., Davis, R.E., Huhns, M., and Valafar, H. Submitted to *Games for Health*, 09/28/2015.

Abstract

Objective: To describe participant engagement and examine predictors of weight loss and points earned through the point-based incentive system of the Social Pounds Off Digitally (POD) app.

Materials and Methods: Overweight and obese adults with Android smartphones/tablets (Body Mass Index 25-49.9 kg/m^2; N=26) were recruited for a three-month weight loss intervention. Participants completed a survey assessing demographics and personality and had their weight measured. Participants received the content of the intervention via podcasts and used the Social POD app to self-monitor diet, physical activity, and weight. The Social POD app contained: tracking features; in-app notifications to track; pre-set goals for tracking; newsfeed for updates on others' goal attainment; ability to earn and track points for usage (exchanged for study-provided prizes); and a message screen. Analyses examined relationships between percent weight loss, demographic and personality characteristics, and total points earned.

Results: A total of 4,912 points were earned (mean = 188 points/participant, ± 110 points/participant). Most participants earned all three prizes (58%), followed by two prizes (19%), no prizes (15%), and one prize (8%). Total points earned significantly predicted percent weight loss (B=-0.02, p=0.01), and higher conscientiousness significantly predicted greater total points earned (B=9.07, p=0.03), but other personality characteristics and demographics did not.

Conclusion: A mobile app yielded high participant engagement, as demonstrated by points earned. Earning points was significantly associated with percent weight loss, and

conscientiousness was significantly associated with total points earned. Future research should examine if point systems impact health behavior and weight loss when rewards are discontinued.

Clinical trial registration number: NCT02344836

Introduction

Rates of overweight and obesity remain high among U.S. adults, with 71% meeting this criteria (Body Mass Index (BMI) >25 kg/m^2).[1] Interventions developed using health behavior theories to improve diet and physical activity (PA) have been successful at promoting weight loss.[2] Mobile health (mHealth), the use of mobile technology (e.g., smartphones, tablets, activity monitors) to improve health behaviors, is an emerging mode of delivery for behavioral interventions.[3–6] Novel mobile applications (apps) have been developed and tested by researchers to deliver weight loss interventions,[7,8] and results demonstrate significant short-term weight loss outcomes.[9] While there are many benefits of delivering weight loss interventions using remote methodologies, such as mobile apps, finding ways to maintain participant engagement (i.e., use) over time can be a challenge.[10]

Past research has focused on providing social support to help maintain participant engagement in remotely delivered interventions. Existing mobile platforms, such as social media (Twitter[6,11] and Facebook),[12–15] text messaging,[15–18] and online support communities[19] have been used as modes of communication to foster social support and maintain participant engagement in previous weight loss interventions. Others have used principles of social gaming and financial incentives to promote engagement in an electronic health intervention for weight loss.[20] Among overweight and obese adolescents, video games have been used to promote engagement with a PA intervention.[21] A mobile app has also been developed using gaming principles to promote healthy eating among children.[22] Most of the current research examining the efficacy of using incentives to promote weight loss among adults has been conducted via face-to-face interventions and typically consists of financial incentives.[23] While a few commercially available apps marketed for weight loss include some type of incentive system [My Diet Coach (Inspired Apps) and Jillian Michaels (Everyday Health, Inc.)]; to our knowledge the incentive systems in these apps have not been rigorously tested to examine how these apps impact weight loss.[24,25]

This paper focuses on the development of a new mobile app [the Social Pounds Off Digitally (POD) app] to test theoretically driven research hypotheses. The main weight loss intervention used constructs from behavioral theories, including Social Cognitive Theory (SCT) [26,27] and the Socio-Ecological Model[28] to promote self-monitoring of diet, PA, and weight and promote participant engagement and motivation to enhance weight loss in this completely remotely delivered intervention. Extrinsic motivation, whereby behavior is performed for reasons external to the individual,[29,30] was explicitly targeted through the use of a point-based incentive system developed based on feedback from participants during the pilot testing of the Social POD app.[31] With this point-based incentive system, participants earned points for using the diet, PA, and weight self-monitoring features of the app and for sending others encouragement (targeting positive reinforcement from SCT[26] and operant conditioning[32–34]).

The purpose of this paper is to describe participant engagement with the point system, examine the association between percent weight loss and total points earned, and examine predictors (demographic and personality characteristics) of points earned through the incentive system of the Social POD app. It was hypothesized that total points earned would be significantly associated with weight loss (via self-regulation)[27] and that younger adults would earn more points than older adults, since this group uses mobile technology more frequently.[35] Given the research supporting the association between high conscientiousness and high achievement[36] and rule-following,[37] engaging in protective health behaviors[38] as well as health outcomes later in life (low conscientiousness associated with greater adiposity, BMI, morbidity, and mortality),[38–41] it was hypothesized that higher conscientiousness would be significantly associated with greater points earned. This study, to our knowledge, is the first to examine results from a point-based incentive system incorporated into a mobile app for adults, which is significant given the need to find methods to sustain long-term diet, PA, and weight self-monitoring behaviors over time to promote weight loss and maintenance.[42]

Methods

Participant Recruitment and Measures

Overweight and obese men and women from two mid-size cities in South Carolina with Android smartphones/tablets (Body Mass Index 25-49.9 kg/m^2; N=51) were recruited for a three-month weight loss intervention. Participants were recruited via university and worksite listserv announcements, community/worksite flyers, newspaper advertisements, university/worksite electronic newsletters, social media posts, handouts at a local research fair, and word of mouth.

Exclusion criteria included not having an Android phone/tablet, BMI outside the range of 25.0-49.9 kg/m^2, unable to attend required meetings, unable to access a computer or internet to complete assessments, having a psychiatric illness, receiving treatment for drug or alcohol dependency, having an eating disorder, participating in another weight loss program, reporting weight loss of ten pounds or more in the past six months, being pregnant or planning on becoming pregnant during the study, or currently breastfeeding. Exclusion criteria also included endorsing select items from the PA Readiness Questionnaire[43]: being told by a doctor that they have a heart condition and should only participate in approved PA; feeling chest pain with or without engaging in PA in the past month; and ever losing balance, becoming dizzy, or losing consciousness. If participants reported a bone or joint problem that could be made worse by participating in PA or taking blood pressure medication, they were required to submit a physician consent form to participate in the study.[43] Participants received a total of $10 for completion of all assessments.

Participants attended a total of three in-person measurement sessions. The first was an orientation session where they received a detailed description of the study and received instruction for completing all baseline assessments. Following orientation, participants completed a baseline survey assessing demographics (age, ethnicity, educational attainment, employment status, and marital status). The previously validated Big Five Inventory, measuring the personality characteristics of extraversion (energetic and lively traits), neuroticism (negative and anxious traits), openness (creative and openminded traits), conscientiousness (task-oriented and organized traits), and agreeableness (trusting and compliant traits) was also completed at baseline.[44] Participants who completed the baseline questionnaire were randomized to one of two groups and attended a training session where they were told to which intervention group they were assigned and received instruction regarding how to use the intervention components. Baseline and three-month weight measures (SECA 869, Hamburg, Germany, calibrated digital scale accurate to 0.01 kg) were obtained by trained staff at the training and final sessions. All participants provided written consent, and this study was approved by a university Institutional Review Board.

Experimental and Comparison Conditions

In addition to using a tracking app to self-monitor diet, PA, and weight, participants in both conditions received two theory-based podcasts each week. Specific information regarding podcast development and testing in previous interventions can be found elsewhere.[4,6] Podcast topics included: nutrition and PA information focused on achieving a healthy weight; a male and female character documenting their weight loss progress and challenges through an audio diary; a weight loss drama depicting the challenges of overcoming social barriers to weight loss; and a goal setting activity related to healthy behaviors that promote weight loss at the end of each episode.

Experimental group participants used the Social POD app developed by the authors for the Android platform. The Social POD app included diet, PA, and weight tracking features, as well as a journal feature, calorie database, weight graph, in-app notifications, message page, newsfeed, goals page, and point tracker. A description of the development, pilot testing, and subsequent revision of the Social POD app has been previously documented.[31]

Within-app notifications were sent via the Social POD app at specific times throughout the day to remind participants to self-monitor diet, PA, and weight each day. Participants entered calories consumed from all meals and snacks, minutes of PA completed, and body weight in order to promote self-regulation.[27] Participants who regularly used the Social POD app were also prompted by notifications to send pre-written encouraging messages to participants who had not entered data in the app over the previous 48 hours. These messages were developed targeting social support,[11] and SCT to target self-efficacy[26,27] and outcome expectations,[45] which, together, were believed to encourage self-monitoring of diet, PA, and weight.

An incentive system with goals, newsfeed, and point tracker (targeting reinforcement from SCT[26] and operant conditioning),[32–34] were incorporated into the Social POD app. Goals were set by the study team for using the Social POD app for tracking diet, PA, and weight (e.g., logging diet, weight, and 30 minutes of PA for the day) and for sending daily encouragement to others. Participants could view other participants' progress with these goals on the newsfeed and send them encouraging messages ("stars") for achieving goals. During the training session, participants were told how many prizes they could earn for each point level. Points were redeemed for study-provided prizes at the final meeting at three months

The number of points that a participant could earn was based on the total number of points possible over the course of the study for the following activities: 1) tracking calories every day (one point for logging at least one meal or snack each day); 2) tracking weight every day (one point for doing this one time per day); 3) logging at least 30 minutes of physical activity per day (one point for logging at least 30 minutes per day); 4) sending a "star" from the newsfeed to other participants as encouragement for completing a goal (maximum of one point per day). Participants could earn a total of four points per day for a total of 336 possible points. The prizes and numbers of points needed to earn each prize were as follows: Level One, pedometer, 60 points; Level Two, pedometer and a sweat towel, 120 points; and Level Three, pedometer, water bottle, and sweat towel, 180 points.

A secure network server collected and stored all participant activity with the Social POD app throughout the intervention. Participants in the comparison group used a standard tracking app called Calorie Counter (Fat Secret, © 2015), which included a number of features: calorie database and meal tracker; PA database and PA tracker; weight tracker with a graph; recipe index; periodic email reminders to weigh in; and journaling feature. Following the intervention, all participants attended a final session where final weight measurements were obtained.

Statistical Analysis

The goals of the analyses were to describe participant use of a point-based incentive system and to examine predictors of weight loss and points earned among experimental group participants in the Social POD Study. Data from comparison group participants is not included in this analysis. A linear regression model was used to assess the relationship between percent weight loss and total points earned at three months. Separate multiple regression models were used to assess relationships between total points earned and sets of predictors: (1) demographic characteristics (age, gender, ethnicity, and educational attainment); and (2) the Big Five personality characteristics in separate models.[38] Responses for participant ethnicity were collapsed to form two groups (White, n=15, and Other, n=11). Responses for educational attainment were collapsed to some college or college degree (n=16) and graduate degree (n=10).

Assumptions were checked for all regression models including normality of residuals, significant outliers, homoscedasticity, independence of errors, and linearity. No significant outliers were detected in any of the models and no observations were removed. Intent-to-treat analysis with baseline observations carried forward was used in the calculation of percent weight loss for missing final weight values for experimental group participants (n=3). All data was collected and analyzed between February and September of 2015 using Stata version 13.1 (StataCorp, 2013) with $p < 0.05$ to detect statistical significance.

Results

Main Study Outcomes

There were 26 participants randomized to the experimental group in the main study (with n=25 randomized to the comparison group). Two participants were excluded in the analyses with percent weight loss due to reported contraindicated medication and surgery affecting body weight. Participants in this study were mostly White (58%) females (85%) with a mean BMI of 36.2 ± 6.3 kg/m^2 and mean age of 48.4 ± 11.9 years (Table 1).

Engagement with the Social POD Point System

The total number of Social POD app entries was 11,423 with a mean of 456.9 entries per participant (SD ± 298.6, minimum 0, maximum 980 entries). A total of 4,912 points were earned by participants with a mean of 188.9 points earned per participant (SD ± 110.6, minimum 0, maximum 374 points). Most experimental group participants earned all three prizes (n=15, 58%), followed by two prizes (n=5, 19%), no prizes (n=4, 15%), and one prize (n=2, 8%).

Weight Loss, Points Earned, and Predictors of Points Earned

Total points earned significantly predicted percent weight loss such that for every 50 points earned, participants lost one percent of body weight (B=-0.02, p=0.01). None of the demographic characteristics significantly predicted total points earned, including age (B=-0.60, p=0.80), gender (B=59.79, p=0.40), ethnicity (B=46.72, p=0.40), and education (B=-36.48, p=0.48). Greater conscientiousness significantly predicted total points earned (B=9.07, p=0.03), but none of the other personality characteristics were significant predictors of earning points, including neuroticism (B=-0.57, p=0.89), extraversion (B=-2.15, p=0.56), agreeableness (B=0.31, p=0.95), and openness (B=-4.53, p=0.16).

Discussion

Participant engagement with point systems

The present study examined the role of a mobile app that used a point system to engage participants in a remotely delivered, weight loss intervention for overweight and obese adults. In this current study, participant engagement with the point system was high, with most participants achieving the highest prize level (> 180 points) and earning all three study-provided prizes. Currently there is little research on the use of mobile app-based point systems to engage adults participating in remotely delivered weight loss interventions. In the current literature examining researcher-developed mobile apps for weight loss among adults, none included any type of incentive system.[7,8]

Weight Loss and Points Earned

The Social POD app fills gaps in the literature regarding the development and testing of a point system to incentivize use of a weight loss mobile app for adults. In the Social POD study, points earned significantly predicted percent weight loss, indicating that providing overweight adults with the ability to earn incentives for self-monitoring their diet, PA, and weight and sending encouragement to others could help promote weight loss. A review of RCTs providing incentives to improve levels of PA concluded that incentives successfully improved PA outcomes during the interventions examined.[34] A review by Burns et al., suggested that using material incentives could especially help motivate those individuals who are not intrinsically motivated to perform healthy behaviors to promote weight loss.[32] However, other reviewers have concluded that providing external rewards during interventions does not undermine performance of healthy behaviors related to weight loss and PA, even when initial levels of intrinsic motivation for performing these behaviors is high.[33]

Another study found similar results as the Social POD study when examining the correlation between financial incentives and weight loss. This study, conducted by John et al.,[46] found a significant correlation between performance (weight loss) and receiving financial incentives in a deposit-contract group as compared to a control group (without financial incentives).[46] Similar to Social POD, results of this study indicated that incentives (frequency and the total number of deposits) were significantly correlated with weight loss in the deposit-contract group.[46]

Predictors of Point Earning

The Social POD study also sought to identify characteristics, including demographics and personality traits, of participants who earned points with the Social POD app to aid in potentially tailoring future incentive systems. Most game-based incentive systems (e.g., earning points and prizes) are geared toward younger participants[47] (children[22] and adolescents[21]), therefore this study sought to determine if variations in demographics, including age and other characteristics, significantly predicted points earned among adults. Results from this study did not support the hypothesis that age was a significant predictor of points earned. A potential explanation for this finding could be that there was not enough variation in demographic characteristics (e.g., age) in this sample to determine if demographics are significantly associated with points earned. Future research with a larger and more diverse sample is needed.

A higher conscientiousness score on the Big Five Inventory significantly predicted greater total points earned in the Social POD Study. This finding is supported by the literature, which shows that higher neuroticism and lower conscientiousness are associated with higher adiposity, BMI, morbidity, and mortality.[38–41] Furthermore, the specific traits that comprise the conscientiousness dimension tend to lend themselves to an individual having a greater internal motivation toward self-regulation (i.e., an intrinsic motivation to excel and follow rules) than other personality dimensions.[36,37] As personality traits are fairly stable in adulthood, results from this study suggest that it could be important to train adult participants with low conscientiousness to perform self-regulatory behaviors typically associated with this trait to promote weight loss (e.g., using frequent reminders to promote self-monitoring of dietary behaviors).[40]

There are some limitations worth noting. This study had a short duration and future research should test if the Social POD app could assist with weight loss maintenance. The Social POD app was only available for the Android operating system, the sample size was small, and the sample consisted of mainly highly educated, middle age, working females, which could limit the generalizability of the results. There are also several strengths of this study. Participant engagement and weight were measured objectively, versus via self-report, which could be subject to bias. This intervention was remotely delivered and therefore less time-intensive for staff and participants than many in-person interventions and could easily be disseminated to reach a much larger population using fewer resources than are typically required by traditional face-to-face interventions.

Conclusions

A mobile app developed by researchers for overweight and obese adults demonstrated high participant engagement with a point-based incentive system. This study demonstrated that earning points was significantly associated with percent weight loss and that high conscientiousness was significantly associated with total points earned whereas demographic characteristics of participants were not. Future research should examine if point systems, like that of the Social POD app, continue to impact health behavior and weight loss when rewards are discontinued as well as whether varying point values could be used to differentially enhance the performance of specific behaviors related to weight loss (e.g., valuing especially important or difficult behaviors at higher point values than others).

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SH, GTM, RD, SW, MH, and HV declare they have no competing financial interests.

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Table 4.6: Baseline Demographic Characteristics and History of Technology Use (N=26)

Characteristics	Experimental Group
Age, mean years (SD)	48.4 (± 11.9)
Gender, n (%)	
Female	22 (85%)
Male	4 (15%)
Race, n (%)	
Black	10 (38%)
White	15 (58%)
Other	1 (4%)
Mean Body Mass Index (kg/m^2) (SD)	36.2 (± 6.3)
Educational Attainment, n (%)	
Some college	3 (12%)
College degree	13 (50%)
Graduate degree	10 (38%)
Employment Status, n (%)	
Student	2 (8%)
Part-time	1 (4%)
Full-time	21 (80%)
Retired	0 (0%)
Out of work	0 (0%)
Other	2 (8%)
Marital Status, n (%)	
Married	9 (35%)
Divorced	4 (15%)
Living with partner	2 (8%)
Never married	10 (38%)
Separated	1 (4%)
Ever downloaded a podcast, n (%)	
Yes	9 (35%)
No	16 (61%)
Do not know	1 (4%)
Ever installed a diet-tracking app, n (%)	
Yes	8 (31%)
No	18 (69%)
Ever installed a PA tracking app, n (%)*	
Yes	12 (48%)
No	13 (52%)

* Missing response (n=1)

4.4: Social POD app User-user Messaging Results

In addition to providing support and motivation for self-monitoring diet, PA, and weight, a goal of this study was to develop and test a method of re-engaging those participants who discontinued the use of these features over time within mHealth weight loss interventions. In order to re-engage infrequent users, frequent app-users (those who entered data within the past 48-hours), were used to send encouraging messages to those who discontinued use of the app (did not enter data within the past 48-hours), as a method of re-engaging these participants with the intervention over time without the need for increased contact from study staff. To reduce the potential for harmful social interactions and to test which theoretical constructs best re-engaged infrequent users, study staff developed pre-written messages targeting health behavior theory constructs (social support, self-efficacy, and outcome expectations). Of interest was examining which message-type was selected most often by frequent users to send to infrequent users and which type of message sent to infrequent users most often resulted in re-engagement (i.e., use of the self-monitoring features of the app) within a limited timeframe (24-hours).

A frequency distribution was used to determine which type of message was sent to infrequent users most often. Fisher's exact test[83] was used to determine if the type of message received and viewed was significantly associated with re-engagement with the Social POD app among infrequent users after a period of 24-hours

Table 4.7 presents the results of user-user messages sent and messages that prompted re-engagement. Messages targeting social support (n=119) were sent most often to infrequent users, followed by outcome expectations (n=99), and self-efficacy (n=97). There was a statistically significant difference between the type of message received (social support, self-efficacy, or outcome expectation messages) and re-engagement among infrequent users (p=0.03). Of the messages sent, received, and viewed by infrequent users, self-efficacy messages resulted in the most frequent re-engagement of infrequent users (n=7), followed by outcome expectations (n=5), and social support (n=1). Overall re-engagement following sending of a message (indicated by an infrequent user being sent a message from the app server) and app re-engagement (indicated by clicking on the notification that a message was received or clicking on the actual message that was received) was very low among infrequent users (13 messages prompting re-engagement out of a total of 315 messages sent to infrequent users).

Table 4.7: User-user Messages and Re-engagement of Infrequent Social POD app Users

	Self-efficacy	**Social Support**	**Outcome Expectations**	**P-value**
Number of messages sent	97	119	99	
Number of messages that re-engaged users	7	1	5	0.03
Percentage of messages that re-engaged users from total number sent	7%	.8%	5%	

Messages targeting self-efficacy followed by outcome expectations resulted in the most instances of re-engagement among infrequent users. Messages targeting self-efficacy were designed to enhance participants' confidence in their ability to perform, and overcome potential barriers to performing, healthy diet and PA behaviors for weight loss and engage in self-monitoring of these behaviors. Outcome expectations messages were designed to provide positive examples of healthy behaviors related to diet and PA and to reframe negative thoughts about performing and self-monitoring these behaviors. Both self-efficacy and outcome expectations messages contained some type of social support (e.g., informational support) whereas social support messages targeted only emotional support and network support and companionship. It could be that the more nuanced message types better re-engaged infrequent users with the self-monitoring features of the Social POD app by providing both social support as well as targeting the additional constructs of self-efficacy and outcome expectations. Future interventions should consider using targeted messages containing some type of social support (such as informational or suggestion sub-types) along with other behavioral theory constructs targeting self-efficacy or outcome expectations to best re-engage those participants who discontinue use of self-regulatory features over time.

Overall there was very low re-engagement of infrequent users in this study. It is possible that there could have been more instances of re-engagement if the timeframe for re-engagement was expanded (e.g., within 48-hours as opposed to 24-hours). Future research should examine if other methods and types of messaging better re-engage infrequent app users in the context of remotely delivered weight loss interventions. It could be that infrequent users did not place as much importance on receiving pre-set messages, as they would have if users were able to tailor the messages being sent. Allowing frequent users to tailor the user-user messages targeting health behavior theory constructs could be tested in future interventions to determine the potential impact on re-engagement of infrequent users. In addition, using alternate methods of matching participants to provide support to one another (e.g., based on user preferences or user history) could be explored as additional methods of tailoring messages to improve re-engagement of infrequent users in the future.[84]

CHAPTER 5

CONLUSIONS

Overall conclusions

The Social POD app provided a way to prompt self-monitoring of dietary intake, weight, and PA while encouraging frequent users to provide support to infrequent users during pilot testing. Use of the Social POD app resulted in significant and clinically meaningful weight loss for experimental group participants as compared to weight loss for those using a standard tracking app in the comparison group following the RCT. The Social POD app connected users to provide social support to one another through user-user messaging; incentivized self-monitoring through a point system; and prompted participants to self-monitor throughout the day, demonstrating that these may be key features to include in mHealth interventions for adult weight loss. This study also showed that earning points was significantly associated with weight loss and that specific personality traits (conscientiousness) were significantly associated with total points earned, whereas demographic characteristics and other personality traits (extraversion, agreeableness, openness, and neuroticism) were not. Messages targeting self-efficacy most frequently re-engaged infrequent users, followed by outcome expectation messages, and then social support messages. Overall re-engagement following receipt and viewing of a message was low, indicating a need for future research to determine the best method of re-engaging infrequent users with mobile apps during remotely delivered weight loss interventions.

Previous research and implications for mHealth and weight loss mobile apps

Currently, there is little published research in the area of development and testing of new mobile apps for weight loss among overweight and obese adults. Studies have documented the development and testing of new apps for adolescent weight loss,[53] the modification of PA behavior of adolescent males,[54] the prediction of childhood obesity among infants,[55] and the improvement of diet and PA behavior of young adults.[56–58]

A weight loss app developed and pilot tested by other researchers also incorporated similar features as those of the Social POD app, including self-monitoring features for weight maintenance-related behaviors (e.g., logging calories consumed), notifications to self-monitor behaviors, and goals for weight management among a young adult population.[56] Similar to findings from the Social POD pilot testing, other researchers found that young adults reported they valued having weight loss goals to achieve in addition to the tracking features typically included in apps targeting weight loss.[57] Another study reported that participants requested positive reinforcement for performing targeted behaviors (e.g., logging minutes of PA), which was also a recommendation by users following the pilot testing of the Social POD app.[58] Results from the Social POD studies, and other studies of weight loss apps developed and tested by researchers, suggest that incorporating features promoting self-monitoring, prompts to self-monitor, goals to achieve, and positive reinforcement (for achieving goals and performing targeted health behaviors) may be critical components for both older and younger adults when designing these mHealth applications.

In the subsequent RCT from Specific Aims 2 and 3 of this dissertation, use of the Social POD app resulted in significantly greater weight loss among experimental group participants than use of the standard tracking app (Fat Secret) among comparison group participants, when both were combined with TBPs targeting constructs from SCT. The RCT also found that there were significant differences in engagement with the mobile app technology, with experimental participants reporting use of the app more frequently than the comparison group. This could explain the differential weight loss outcomes achieved by this group, since maintaining participant engagement over time in mobile interventions is a challenge.[14] It is significant that participants reported using the Social POD app more frequently than those using a standard tracking app. The more proximal data entry is to the actual behavior, the more likely the behavior will be reinforced.[85] Regular prompts to self-monitor from the Social POD app could have contributed to more frequent real-time data entry, thereby resulting in greater reinforcement and significantly greater weight loss outcomes among participants in the experimental group.[85]

Neither group experienced significant changes in social support and self-efficacy for diet and PA behaviors or changes in negative treatment expectations at final measurements. Significant group differences might not have been detected for psychosocial variables given that both groups received the same TBPs, which targeted all three psychosocial variables, and given the short timeframe of the study. Given that there were no significant differences in psychosocial behavioral outcomes related to weight loss by group assignment, it is possible that additional features that engaged, prompted, and motivated participants to use the Social POD app more frequently were responsible for the differential weight loss observed among the two groups. While health behavior theory was useful in designing the Social POD app, changes in these outcomes might not be what drove the changes in health behavior.

While social support user-user messages were sent most often to infrequent users, this message type was the least re-engaging among infrequent users. Message types that included social support and targeted either self-efficacy or outcome expectations were both more engaging than messages targeting social support alone. Overall, infrequent user re-engagement was very low in this study (13 out of 315 messages sent to infrequent users). The purpose of using pre-written user-user messages was to test which type of theoretical construct best promoted re-engagement with the self-monitoring features of the Social POD app. However, since overall re-engagement with pre-written messages was very low, alternative methods of re-engaging infrequent users through an in-app messaging system (e.g., allowing users the opportunity to tailor or personalize pre-written theory-based messages) should be considered in future mobile interventions for weight loss.

While there has been some work recently in the area of mobile app development for weight loss among various populations,[56,58,86,87] there is currently little published research in the area of development and testing of new mobile apps for weight loss among overweight and obese adults.[88] Furthermore, few commercial apps for weight loss have undergone rigorous testing, such as that used in this research, and this is significant given that scholars have called for rigorous testing of these apps to determine their potential public health benefit as well as their potential harm.[15] The Social POD study adds to the current mHealth literature to target adult obesity and has several important implications for future research in this area. Another prior mHealth intervention found similar weight loss outcomes for overweight and obese adults at three months (-5.2 kg) but utilized in-person sessions.[89] The use of a completely, remotely delivered intervention, which resulted in greater weight loss for those using the Social POD app, is significant given the potential for increasing dissemination and reach of such interventions. Furthermore, the Social POD app was developed by researchers to objectively test health behavior theoretical constructs related to diet and PA behaviors and can be used in subsequent research to test other theoretical constructs as well. Finally, features of the Social POD app (e.g., point-based incentives and/or theory-based messaging) can be incorporated into various other mobile platforms and media as technology evolves (as compared to commercial app features) for greater potential public health impact.

Participant engagement and predictors of weight loss and points earned among experimental group participants

In the RCT, participant engagement with the point system was high, with a large percentage of participants achieving the highest prize level (> 180 points) and earning all three study-provided prizes. Currently there is little research on the use of mobile app-based point systems to engage adults participating in remotely delivered weight loss interventions. In the current literature examining researcher developed mobile apps for weight loss among adults, none included any type of incentive system.[86,89] Of the commercial apps marketed for weight loss, we are aware of only two that contain any type of incentives, with only one app (My Diet Coach) that we are aware of currently offering incentives for Android users.

The Social POD app fills gaps in the literature regarding the development and testing of a point system to incentivize use of a weight loss mobile app for adults. In the Social POD study, points earned significantly predicted percent weight loss, indicating that providing overweight and obese adults with the ability to earn incentives for self-monitoring their diet, PA, and weight and sending encouragement to others could help promote weight loss. Another study found similar results as the Social POD study when examining the correlation between financial incentives and weight loss. This study found a significant correlation between performance (weight loss) and receiving financial incentives as compared to a control group without financial incentives.[90] Those designing remotely delivered behavioral interventions should strongly consider incorporating opportunities for participants to receive incentives, to receive and provide encouragement to one another, and to enhance self-regulation and weight loss outcomes, especially among overweight and obese adults.

The Social POD study also sought to identify characteristics, including demographics and personality traits, of participants who earned points with the Social POD app to potentially tailor future mHealth weight loss interventions for specific groups of individuals. Of interest was whether age was a significant predictor of points earned, such that younger participants earned more points than older participants. There were no significant associations found between demographic characteristics of participants and points earned. A potential explanation for this finding could be that there was not enough variation in demographic characteristics in this sample to determine if demographics were significantly associated with points earned. Although most game-based incentive systems (e.g., earning points and prizes) are geared toward younger participants[91] (children[92] and adolescents[93]), overall high participant engagement with the point-based incentive system of the Social POD app could indicate that these types of gaming features are critical to enhancing engagement of all users in these types of interventions, regardless of age and other demographic characteristics.

A higher conscientiousness score on the Big Five Inventory significantly predicted greater total points earned in the Social POD Study. This finding is supported by the literature surrounding personality and health behaviors and resulting morbidity and mortality.[94–97] In addition, traits associated with high conscientiousness (e.g., following rules and a high intrinsic motivation to excel at tasks)[98,99] most likely contributed to greater user adherence to the intervention (e.g., self-monitoring and sending encouragement to others when prompted) and subsequent higher point earning. While personality traits are fairly stable in adulthood, results from this study suggest that it could be helpful to incorporate features to help train adult participants with low conscientiousness to perform behaviors typically associated with conscientiousness (e.g., self-regulation) to promote weight loss (e.g., using frequent reminders to promote self-monitoring of dietary behaviors).[97] In addition to promoting self-regulation among those with low conscientiousness, it could be helpful to foster an intrinsic motivation to perform targeted tasks related to weight loss among those with low conscientiousness.[98] This could be accomplished by using pre-set goals including a combination of both extrinsic motivators (e.g., earning points) and intrinsic motivators (e.g., responsibility to help encourage others in the group) for performing tasks (e.g., logging calories each day or sending "stars" to other users), and allowing participants to choose goals from each category to achieve throughout the intervention. Finally, interventionists could use self-reported personality traits to better match participants to specific weight loss/weight management interventions.[100] For example, those with high conscientiousness scores could receive interventions with greater social interaction among participants to promote weight loss (similar to the user-user messaging and incentive systems the Social POD app) whereas those with high neuroticism scores could receive interventions based on reduced calorie/prescribed eating plans to achieve weight loss and weight maintenance.[100]

Limitations of research and findings

There are several limitations with the usability testing (Specific Aim 1) of the Social POD app. As the purpose of this study was to test the first iteration of the Social POD app prior to the pilot RCT, this study was not adequately powered to detect statistically significant differences in pre-post scores. The time period of the study was also very short and may have been too short to detect significant differences in participant pre-post body weight after just two months. While weight and height were objectively measured, participant self-report was used when measuring calories consumed on the ASA 24-hour dietary recall and calories expended during activity on the Paffenbarger PA Questionnaire (versus an objective measure of PA). The Social POD app is currently only available for the Android operating system. Despite the fact that the Android phone is the most prevalent cell phone in the U.S.,[101] the fact that other smartphone users (such as iPhone users) were excluded may reduce the generalizability of the findings. The sample size of this study was also very small, at just nine participants, one male, and with mostly white participants and was therefore not a representative sample of all potential users of the Social POD app.

There are several limitations with the RCT in Specific Aims 2 and 3. The study had a short duration. Future research should see if the Social POD app could assist with weight loss maintenance. Participant self-report was used when measuring calories consumed and calories expended and these measurements could be subject to potential recall bias. Neither research staff nor participants were blinded to group assignment, the study sample size was small, and the sample was mostly highly educated, white, females which limits the generalizability of the results. The goals and incentives targeted only extrinsic motivation and external reinforcements and did not incorporate any type of intrinsic motivators or internal reinforcements of healthy behaviors, which has the potential to promote longer lasting health behavior changes and help participants maintain weight loss over time.[102] There was also low participant re-engagement with the Social POD app following receipt and viewing of a user-user message during the RCT.

Possible areas of future research

The Social POD app should be tested in a larger clinical trial for a greater length of time to determine if changes in participant weight, calories consumed, and calories expended during PA are maintained over time. Future research should also examine if point systems, like that of the Social POD app, continue to impact diet and PA health behavior and weight loss when rewards are discontinued. Varying the point values assigned to performing specific behaviors could be another avenue of future research to enhance participant motivation for using specific features of the Social POD app. Future iterations of the Social POD app should also focus on incorporating some type of intrinsic motivation and test how the different types of motivation (autonomous vs. controlled) impact health behavior and weight loss outcomes among overweight and obese adults.

Subsequent studies should continue to refine methods for best re-engaging those participants who discontinue use of diet tracking apps through messaging features, such as those utilized in the Social POD app. Testing the user-user messaging system among a larger sample of participants, for a longer amount of time, and allowing for tailoring of messages could be examined in future studies. Finally, the efficacy of mHealth weight loss applications, such as the Social POD app, should be tested among a more demographically diverse sample of participants (e.g., more diverse educational attainment, genders, and ages) in the future.

In addition to future research opportunities, there is the potential to embed various components of the Social POD app in other apps and other types of technology to modify diet and PA behaviors and impact weight loss on a greater scale. Using recommender systems from other applications served as the basis for randomly matching frequent and infrequent users to prompt re-engagement with the Social POD app.[84] There is the potential to use more sophisticated recommender systems, such as those employed by websites and applications (e.g., Netflix and Amazon)[62–65] to further modify health behaviors. For example, utilizing information obtained from a participant's past app entries (e.g., logging 30 minutes of walking) could help tailor future recommendations to modify diet and/or PA behaviors to promote weight loss (e.g. if a participant has not logged PA by 6:00pm, a recommendation could be made to go on a 30 minute walk). Furthermore, a point system, such as that utilized in the Social POD app, could be incorporated into existing mobile apps, websites, as well as other newer technologies including wearables (e.g., smart watches, activity monitors, or bite counters) to promote participant encouragement with these mobile devices. The user-user messaging components of the Social POD app could also be incorporated into most technologies to re-engage those who discontinue use of these devices over time via messages targeting social support combined with self-efficacy or outcome expectations. Collaborations among health behavior researchers and those in the technology industry will be necessary to further dissemination and implementation of evidence-based practices in this growing area of mHealth. In addition, collaborations with health behavior researchers and clinicians (e.g., doctors, registered dieticians, nurses, and health educators) will be an important next step to better integrate evidence-based mHealth technologies (e.g., weight loss apps) in everyday practice to modify diet and PA behaviors and reduce the impact of chronic disease associated with overweight and obesity.

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APPENDIX A – AIM 1 PARTICIPANT CONSENT FORM

Department of Health Promotion, Education, and Behavior

Arnold School of Public Health

Consent Form

The Efficacy of Agent-Mediated Social Networks for Modeling Healthy Behaviors

Brie Turner-McGrievy, PhD, MS, RD; Homayoun Valafar, PhD; Michael Huhns, PhD; Sara Wilcox, PhD; Patrick Malone, PhD

Introduction and Purpose

You are invited to participate in a research study conducted by Brie Turner-McGrievy, a professor in the Health Promotion, Education, and Behavior Department at the University of South Carolina. This study is funded by the South Carolina Clinical and Translational Research Institute. You are being asked to participate in this research study because you are interested in achieving a healthy weight. The purpose of the study is to test the usability of a mobile weight loss intervention that uses social networking. We also aim to explore if this type of intervention produces weight loss. This form explains what you will be asked to do if you decide to participate in this study. Please read it carefully and feel free to ask any questions you like before you make a decision about participating.

Description of Study Procedures

This study will last approximately 3 months (about 12 weeks). You will need to attend one 2-hour orientation meeting at the beginning of the study, a 1-hour baseline assessment meeting, and then a 1-hour meeting at the end of one month, two months, and 3 months (5 meetings total). You will listen to 2 podcasts per week. You will also be encouraged to monitor your exercise, dietary intake, and body weight and engage in some support delivered via your

Android mobile device. Each of the podcasts will take about 15 - 20 minutes to listen to and so you should expect to spend 30 - 40 minutes each week listening to podcasts and up to 3 hours completing other study-related activities each week—including completing a brief (5 minute) weekly survey—for a total of 3.5-4 hours per week.

Below are the steps in the study:

- If you are accepted into the study, you will come to the study site (USC School of Public Health) to learn more about the study, how to download the podcasts, and complete your consent form.
- From a computer at home, you will complete some questionnaires that will measure your diet and PA levels at home from a computer.
- You will attend smaller group meeting to have your weight and height measured and be trained to use your mobile device for the study.
- You will log on to the study Web site at least 2 times per week where you will download a podcast. You will also be asked to use your internet-capable phone to receive diet and PA tips and interact with other study participants.
- Throughout the study (from the beginning through 3 months), you will be asked to complete a brief weekly survey to assess your current level of participation. This will take approximately 5 minutes to complete.
- Each month, we will ask you to come in to provide feedback on the study activities, which will allow us to make improvements. We will also ask to view any records you have used to keep track of your weight, diet, and PA.
- At study completion (3 months), you will come to a follow-up assessment to be weighed, and to complete the follow-up questionnaires. We will also ask to view any records (diaries) that you have used to keep track of your weight, diet, and PA.
- If you become pregnant during the course of the study, you will be dropped from the weight loss study.

Where and when participation occurs

Time/Task	Location
Orientation visit	At Arnold School of Public Health
Baseline questionnaires	On a computer from your home or other location of your choosing
Baseline assessment and orientation to the study components	Arnold School of Public Health
Months 0-3: Follow the weight loss diet and receive support	Weekly podcasts (2 per week) and additional support provided via your mobile device; Weekly surveys completed on a computer from your home or other location of your choosing; Monthly meetings at the Arnold School of Public Health
3-month questionnaires	On a computer from your home or other location of your choosing
3-month weight assessment	Arnold School of Public Health

At each time point (baseline and the end of 3 months); we will measure your weight and height. In addition, we will ask you to complete questionnaires on eating behaviors and dietary acceptability. These questionnaires may include some sensitive or personal information (such as your age, ethnicity, and questions about your eating habits and preferences). We will also ask you to report everything you ate or drank over the previous 24 hours on 2 separate but unannounced days during the course of the study. These dietary "recalls" will be reported using an online dietary data collection site developed by the National Cancer Institute.

Risks of Participation

The risks of participating in this research study are minimal. We will collect some personal information about your health and dietary habits during the study but these will only be identified with a number (not your name) and will be stored on a password protected server.

Benefits of Participation

This research is designed to benefit society by gaining new knowledge about the use of social networks to help provide support during a weight loss intervention. The benefits to you from being in this study may be learning new information about healthy eating. You may also lose weight, which may help to reduce your risk of developing chronic diseases such as diabetes, some forms of cancer, or heart disease. You may also learn new and healthy cooking tips as well as tips when dining out.

Costs
It will not cost you anything to be in this study. You will be responsible for your transportation costs for the 3 total visits you will have to the USC School of Public Health.

Payments
You may receive up to a total of $30 for attending the group meetings ($10 per meeting at 1 month, 2 months, and 3 months).

Circumstances for Dismissal from the Study
You may be dismissed from the study without your consent for various reasons, including the following:

- If you do not keep appointments for study visits or fail to complete study activities (e.g. failure to complete forms).
- If you do not follow the instructions you are given.
- If the investigator believes that it is not in your best interest to continue in the study.
- If you become pregnant.

Compensation for Injury
In the unlikely event that you sustain an injury related to the research, the research staff will provide first aid and assist you in obtaining appropriate medical care; however, medical expenses will have to be paid by you or your insurance provider. The University of South Carolina has not set aside funds to compensate you for any complications or injuries, or for related medical care. However, by signing this form, you are not waiving any of your legal rights.

Confidentiality of Records
Participation will be confidential. A number will be assigned to each participant at the beginning of the project. This number will be used on project records rather than your name, and no one other than the researchers will be able to link your information with your name. Study records/data will be stored in locked filing cabinets and protected computer files at the University of South Carolina. Electronic data obtained through online surveys or transmitted by your mobile phone will be stored on a secure, password-protected server. This information will not contain your name. You will be assigned a participant number to use on your surveys and you may choose a username for the social network, which does not identify you (e.g., you may choose a pseudonym or made up name). The results of the study may be published or presented at professional meetings, but your identity will not be revealed. While we will make every effort to protect your privacy, it cannot be absolutely guaranteed. In rare cases, a research study may be evaluated by an oversight agency, such as the U.S. Office for Human Research Protections. If this occurs, records that identify you and the consent form signed by you may be inspected so that they may evaluate whether the study is properly conducted and the rights of participants were adequately protected.

Contact Persons

For more information concerning this research or if you believe you may have suffered a research related injury, you should contact Brie Turner-McGrievy at (803) 777-3932 or e-mail brie@sc.edu.

If you have any questions about your rights as a research subject contact, Lisa Marie Johnson, IRB Manager, Office of Research Compliance, University of South Carolina, 901 Sumter Street, Byrnes 515, Columbia, SC 29208, Phone: (803) 777-7095 or LisaJ@mailbox.sc.edu. The Office of Research Compliance is an administrative office that supports the USC Institutional Review Board. The Institutional Review Board (IRB) consists of representatives from a variety of scientific disciplines, non-scientists, and community members for the primary purpose of protecting the rights and welfare of human subjects enrolled in research studies.

Voluntary Participation

Participation in this study is voluntary. You are free not to participate or to withdraw at any time, for whatever reason, without negative consequences. In the event that you do withdraw from this study, the information you have already provided will be kept in a confidential manner.

Signatures/Dates

Signature of participant

I have read (or have had read to me) the contents of this consent form and have been encouraged to ask questions. I have received answers to my questions. I give my consent to participate in this study, although I have been told that I may withdraw at any time without negative consequences. I have received (or will receive) a copy of this form for my records and future reference.

____ ________________

Signature of Research Subject Date

____

Printed Name of Research Subject

For IRB Staff Use Only
University of South Carolina
IRB Number: Pro00024600
Date Approved 3/26/2013
Version Valid Until: 3/25/2014

Appendix B – Aim 1 Pre-study Questionnaire

Demographic Questionnaire (only administered at baseline)

1. Participant number__________

2. Your initials: __________

3. Age: _______________

4. Height: ______________

5. Weight: ______________

6. Gender (select one): Male Female

7. Are you Hispanic or Latino: YesNo

8. Ethnicity (select one):
    a. American Indian or Alaska Native
    b. Asian
    c. Black or African American
    d. Native Hawaiian or Other Pacific Islander
    e. White

9. Education (select one):
    a. 8th grade or less
    b. Some high school
    c. High school diploma or equivalent
    d. Some college
    e. College degree or equivalent
    f. Advanced degree (Masters, doctoral, or other post-college degree)

10. What is your present work status?

a. Working full-time

b. Working part-time

c. Homemaker

d. Student

e. Retired

f. Unable to work or disabled Out of work

G. Out of work

H. Other

11. Which of the following best describes your current marital status? (Morris ACS Survey)

a. Never Married

b. Living with a partner

c. Married

d. Separated

e. Divorced

F. Widowed

G. Don't Know

H. Refused

12. Do you own an Android internet-capable mobile phone (select one)? Yes No

g. If yes, for how long? (enter number of months and/or years): ______________________

h. What kind do you have (what brand and model)? __________________________

13. Have you ever downloaded a podcast before (circle one):

i. Yes
j. No
k. I don't know

14. Have you downloaded a health-related podcast before, such as one that promotes healthy eating, weight loss, or exercise?

l. Yes
m. No
n. I don't know

15. Have you ever installed an application ("app") to your internet mobile device to help you eat better?

o. Yes (If yes, please list all) ______________________
p. No
q. I don't know

16. Have you ever installed an application ("app") to your internet mobile device to help you improve your PA?

r. Yes (If yes, please list which ones)
s. No
t. I don't know

17. How many hours a day do you spend online on a computer? ____________________

18. Are you a member of any social networking sites (such as Twitter, Facebook, MySpace, LinkedIn, etc.)?

u. Yes (If Yes, go to question 19)
v. No (end of demographics survey)

19. Please select all of the social networking sites of which you are currently a member:

w. Facebook
x. MySpace
y. Twitter
z. Friendster
aa. Flixster
bb. Tagged
cc. LinkedIn
dd. Classmates.com
ee. LiveJournal
ff. Other (please list all) ___________________________

Paffenbarger Questionnaire: EXERCISE HABITS

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1. Was there anything about the past week that made exercising especially different for you in terms of extended illness, injury, or vacation?

☐$_1$Yes If "YES", please complete this questionnaire about the previous week.

☐$_2$No If "NO", please complete this questionnaire about this past week.

---

2. First, we are interested in the number of flights of stairs you climbed on average **EACH DAY** in this past week. We only want to know the number of flights you climb going <u>UP</u> - not down.

When answering this question, One Flight of Stairs = 10 steps if you know the number of steps.

❑❑ Flights per day

---

3. Next, we want to know how many city blocks or their equivalent you walked on average **EACH DAY** in this past week. We are only interested in walking done out of doors and walking done indoors for the sole purpose of exercise. We do not want walking done around the house or at work.

When answering this question, consider that 12 city blocks = 1 mile. If you do not know the blocks or distance, 20 minutes of walking = 12 city blocks.

❑❑ Blocks per day

---

4. Were there any sports, fitness, or recreational activities in which you participated during the past week? We are interested only in time that you were physically active. For example, if you lift weights only include the time that you actually are lifting the weights, not the time you spend moving from machine to machine.

***Note: All walking should only be included in Question 3**

***Note: Household activities such as cleaning and laundry are not to be included here as they are not considered to be a sport, fitness, or recreational activity.**

Sport, Fitness, or Recreation	**Times per Week**		**Average Time per Episode**
a.	❑❑		❑❑❑ Minutes
b.	❑❑		❑❑❑ Minutes
c.	❑❑		❑❑❑ Minutes

d.	❏❏		❏❏❏ Minutes

5. Would you say that during the past week (the week used for questions 2-4) you were:

- ❏ less active than usual
- ❏ more active than usual
- ❏ about as active as usual

6. At least once per week, do you engage in regular activity akin to brisk walking, jogging, bicycling, etc. long enough to work up a sweat, get your heart thumping, or get out of breath?

	❏	Yes	❏❏ times per week; Activity:	
	❏	No		

7. On a usual weekday and a weekend day, how much time (to the nearest 1 hour) do you spend on the following activities? ***The total for each day should add to 24 hours***

Sport, Fitness, or Recreation	**Usual Weekday** **Hours per Day**	**Usual Weekend Day** **Hours per Day**
a) Vigorous Activity (digging in the garden, strenuous sports, jogging, aerobic dancing, sustained swimming, brisk walking, heavy carpentry, bicycling on hills, etc.)	❏❏	❏❏
b) Moderate Activity (housework, light sports, regular walking, golf, yard work, lawn mowing, painting, repairing, light carpentry, ballroom dancing, bicycling on level ground, etc.)	❏❏	❏❏

c) Light Activity (office work, driving car, strolling, personal care, standing with little motion, etc.)	❑❑	❑❑
d) Sitting Activity (eating, reading, desk work, watching TV, computer work, listening to the radio, etc.)	❑❑	❑❑
e) Sleeping or reclining	❑❑	❑❑

<u>WEL-Q Questionnaire</u>

1. I can resist eating when I am anxious (nervous).

1 2 3 4 5 6 7 8 9

Not confident — Very confident

2. I can resist eating when I am depressed (or down).

1 2 3 4 5 6 7 8 9

Not confident — Very confident

3. I can resist eating when I am angry (or irritable).

1 2 3 4 5 6 7 8 9

Not confident — Very confident

4. I can resist eating when I have experienced failure.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

5. I can control my eating on the weekends.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

6. I can resist eating when there are many different kinds of food available.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

7. I can resist eating even when I am at a party.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

8. I can resist eating even when high-calorie foods are available.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

9. I can resist eating even when I have to say "no" to others.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

10. I can resist eating even when I feel it's impolite to refuse a second helping.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

11. I can resist eating even when others are pressuring me to eat.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

12. I can resist eating even when I think others will be upset if I don't eat.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

13. I can resist eating when I feel physically run down.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

14. I can resist eating even when I have a headache.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

15. I can resist eating when I am in pain.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

16. I can resist eating when I feel uncomfortable.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

17. I can resist eating when I am watching TV.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

18. I can resist eating when I am reading.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

19. I can resist eating just before going to bed.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

20. I can resist eating when I am happy.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

Eating Behavior Inventory

Directions: Check the number that best describes your behavior during the last 6 months.

	Never or Hardly ever	Some of the time	About half of the time	Much of the time	Always or almost always
A. I carefully watch the quantity of food that I eat.	☐1	☐2	☐3	☐4	☐5
B. I eat foods that I believe will aid me in losing weight.	☐1	☐2	☐3	☐4	☐5
C. I keep 1 or 2 raw vegetables available for snacks.	☐1	☐2	☐3	☐4	☐5
D. I record the type and quantity of food which I eat.	☐1	☐2	☐3	☐4	☐5
E. I weigh myself daily.	☐1	☐2	☐3	☐4	☐5
F. I refuse food offered to me by others.	☐1	☐2	☐3	☐4	☐5
G. I eat quickly compared to most other people.	☐1	☐2	☐3	☐4	☐5
H. I consciously try to slow down my eating rate.	☐1	☐2	☐3	☐4	☐5

I. I eat at only one place in my home.	☐1	☐2	☐3	☐4	☐5
J. I use the same placemat and other utensils for each meal.	☐1	☐2	☐3	☐4	☐5
K (11). I eat and just can't seem to stop.	☐1	☐2	☐3	☐4	☐5
L. I eat in the middle of the night.	☐1	☐2	☐3	☐4	☐5
M. I snack after supper.	☐1	☐2	☐3	☐4	☐5
N. My emotions cause me to eat.	☐1	☐2	☐3	☐4	☐5
O. I buy ready-to-eat snack foods for myself.	☐1	☐2	☐3	☐4	☐5
P. I shop when I'm hungry.	☐1	☐2	☐3	☐4	☐5
Q. I shop from a list.	☐1	☐2	☐3	☐4	☐5
R. I leave food on my plate.	☐1	☐2	☐3	☐4	☐5
S. I serve food family style (serve from bowls on table).	☐1	☐2	☐3	☐4	☐5
T. I watch TV, read, work, or do other things while I eat.	☐1	☐2	☐3	☐4	☐5
U. If I'm served too much, I leave food on my plate.	☐1	☐2	☐3	☐4	☐5
V. Generally, while I'm at home, I leave the table as soon as I finish eating.	☐1	☐2	☐3	☐4	☐5
W. I keep a graph of my weight.	☐1	☐2	☐3	☐4	☐5
X. I eat when I'm not really hungry.	☐1	☐2	☐3	☐4	☐5
Y. I store food in containers where it is not readily visible or in a closed cupboard.	☐1	☐2	☐3	☐4	☐5
Z. I decide ahead of time what I will eat for meals and snacks.	☐1	☐2	☐3	☐4	☐5

Social Support, Eating Habits, and PA Survey

Below is a list of things people might do or say to someone who is trying to improve their eating habits and exercise regularly. We are interested in high fat and high salt (or high sodium) foods. If you are not trying to make any of these dietary changes or are not trying to exercise, then some of the questions may not apply to you, but please read and give an answer to every question.

Please rate each question *twice.* Under *family,* rate how often anyone living in your household has said or done what is described during the last three months. Under *friends,* rate how often your friends, acquaintances, or coworkers have said or done what is described **during the last three months.**

SAMPLE:

A. If my family *rarely makes fun of the foods I eat, and my friends very often* do,

I would answer like this:

A. Made fun of the foods I eat

Family	Friends	Online Social Network (OSN)
A. ___*2*___	A. ___*5*____	A.___*4*___

Please write *one* number from the following rating scale in each space:

none	rarely	a few times	often	very often	n/a
1	2	3	4	5	8

During the past three months, my family (or members of my household), friends, or OSN:

	Family	Friends	OSN
1. Encouraged me not to eat "unhealthy foods"	_____	_____	_____
2. Discussed my eating habit. changes with me	_____	_____	_____

3. Reminded me not to eat high fat, high salt foods.	_____	_____	_____
4. Complimented me on changing my eating habits	_____	_____	_____
5. Commented if I went back to my oId eating habits.	_____	_____	_____
6. Ate high fat or high salt foods in front of me.	_____	_____	_____
7. Refused to eat the same foods I eat.	_____	_____	_____
8. Brought home foods I'm trying not to eat.	_____	_____	_____
9. Got angry when I encouraged them to eat low salt, low fat foods.	_____	_____	_____
10. Offered me food I'm trying not to eat.	_____	_____	_____
11. Exercised with me.	_____	_____	_____
12. Offered to exercise with me.	_____	_____	_____
13. Gave me helpful reminders to exercise	_____	_____	_____
14. Gave me encouragement to stick with my exercise program.	_____	_____	_____
15. Changed their schedule so we could exercise together.	_____	_____	_____
16. Discussed exercise with me.	_____	_____	_____
17. Complained about the time I spend exercising.	_____	_____	_____
18. Criticized me or made fun of me for exercising.	_____	_____	_____
19. Gave me rewards for exercising	_____	_____	_____
20. Planned for exercise on recreational outings.	_____	_____	_____
21. Helped plan activities around my exercise.	_____	_____	_____
22. Asked me for ideas on how *they* can get more exercise	_____	_____	_____
23. Talked about how much they like to exercise.	_____	_____	_____

English Big Five Inventory (administered at baseline)

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others?

Directions: Please choose a number for each statement to indicate the extent to which you agree or disagree with that statement.

1: Disagree strongly

2: Disagree a little

3: Neither agree nor disagree

4: Agree a little

5: Agree strongly

I see myself as someone who . . .

1. is talkative_____

2. tends to find fault with others_____

3. does a thorough job_____

4. is depressed, blue_____

5. is original, comes up with new ideas_____

6. is reserved_____

7. is helpful and unselfish with others_____

8. can be somewhat careless_____

9. is relaxed, handles stress well_____

10. is curious about many different things_____

11. is full of energy_____

12. starts quarrels with others_____

13. is a reliable worker_____

14, can be tense_____

15. is ingenious, a deep thinker_____

16. generates a lot of enthusiasm_____

17. has a forgiving nature_____

18. tends to be disorganized_____

19. worries a lot_____

20. has an active imagination_____

21. tends to be quiet_____

22. is generally trusting______

23. tends to be lazy_____

24. is emotionally stable, not easily upset_____

25. is inventive_____

26. has an assertive personality_____

27. can be cold and aloof_____

28. perseveres until die task is finished_____

29. can be moody_____

30. values artistic, aesthetic experiences

31. is sometimes shy, inhibited_____

32. is considerate and kind to almost everyone_____

33. does things efficiently_____

34. remains calm in tense situations_____

35. prefers work that is routine_____

36. is outgoing, sociable_____

37. is sometimes rude to others_____

38. makes plans and follows through with them_____

39. gets nervous easily_____

40. likes to reflect, play with ideas_____

41. has few artistic interests_____

42. likes to cooperate with others_____

43. is easily distracted_____

44. is sophisticated in art, music, or literature_____

User Control, Cognitive Load, and Novelty

Please answer the following questions.

1. I felt like I was able to *learn at a good pace* during this study.

1 2 3 4 5 6 7

Totally Disagree Completely Agree

2. I felt like I was able to *control the order or sequence of information* I received during this study.

1 2 3 4 5 6 7

Totally Disagree Completely Agree

3. I felt like I was able to *control the content of the information* I received during this study.

1 2 3 4 5 6 7

Totally Disagree Completely Agree

4. How difficult or easy was it to process the information presented during the study?

1 2 3 4 5 6 7

Very Difficult Very Easy

5. How much mental effort did you have to spend when getting the information for this study?

1 2 3 4 5 6 7

A lot of effort Very little effort

6. I found this weight loss intervention to be very new and innovative.

1 2 3 4 5 6 7

Completely disagree Completely agree

7. I found this weight loss intervention to be very unusual and something I haven't done before.

1 2 3 4 5 6 7

Completely disagree	Completely agree

Elaboration Questionnaire

Please answer the following questions on a scale of 1 (not at all) to 7 (very much).

	1-Not at all	2	3	4	5	6	7-Very much
1. How important is the topic of weight loss to you personally?	1-Not at all	2	3	4	5	6	7-Very much
2. How motivated were you to obtain the information from this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
3. To what extent did you try hard to think about the information from this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
4. How much would you say the information from this weight loss intervention held your attention?	1-Not at all	2	3	4	5	6	7-Very much
5. How much effort would you say you gave to evaluating the information from this weight	1-Not at all	2	3	4	5	6	7-Very much

	1-Not at all	2	3	4	5	6	7-Very much
loss intervention?							
6. To what extent did you feel you had enough time to think about the information given in this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
7. To what extent did you find the information in this weight loss intervention well organized and easy to follow?	1-Not at all	2	3	4	5	6	7-Very much
8. In your opinion, how logical and accurate was the information presented in this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
9. To what extent would you say that this intervention made good points about weight loss?	1-Not at all	2	3	4	5	6	7-Very much

APPENDIX C – AIM 1 POST-STUDY QUESTIONNAIRE

Process Evaluation

1. I found that accessing the information was very easy.

1 2 3 4 5 6 7

Totally disagree Completely agree

2. I found that accessing the information for the study was an effective way to get information about weight loss.

1 2 3 4 5 6 7

Totally disagree Completely agree

3. I enjoyed participating in this study.

1 2 3 4 5 6 7

Totally disagree Completely agree

4. I felt that I was able to provide support to other participants as a result of this study.

1 2 3 4 5 6 7

Totally disagree Completely agree

5. I felt that I received adequate support from other participants as a result of this study.

1 2 3 4 5 6 7

Totally disagree Completely agree

6. On average, how often did you listen to the podcasts during the past 3 months?

A. never

B. once a month

C. once a week

D. 2 times a week

E. greater than 2 times per w

7. How many podcasts total did you listen to during the past 3 months? __________

8. Where did you listen to the podcasts for the study? Please circle all that apply.

A. home

B. office/work

C. library

D. café

E. car

F. walking

G. gym/exercising

H. traveling

I. commuting

J. other: _____________________________________

9. Where did you listen to the podcasts ***most often*** during the past 3 months? Please circle only one choice.

A. home

B. office/work

C. library

D. café

E. car

F. walking

G. gym/exercising

H. traveling

I. commuting

J. other: _____________________________________

10. What activity were you doing the most when you were listening to your podcast during the last 3 months?

A. sitting at my desk

B. walking or exercising

C. sitting at home

D. eating

E. driving

F. cleaning/doing housework

G. other: Please describe: ________________________________

11. What device did you use the most to listen to your podcasts?

A. iPod (iPhone, iPod Touch, Nano, etc.)

B. BlackBerry

C. Google Android-based phone

D. Other MP3 player

E. Directly on computer

F. Other: ____________________

12. What internet-capable device did you use during the study?

A. None

B. iPhone

C. iPod Touch

D. BlackBerry

E. Palm Pre

F. My own Android-based phone

G. Provided Android-based phone

H. Other (please specify): ____________________

Paffenbarger Questionnaire: EXERCISE HABITS

1. Was there anything about the past week that made exercising especially different for you in terms of extended illness, injury, or vacation?

☐ $_1$Yes — If "YES", please complete this questionnaire about the previous week.

☐ $_2$No — If "NO", please complete this questionnaire about this past week.

2. First, we are interested in the number of flights of stairs you climbed on average **EACH DAY** in this past week. We only want to know the number of flights you climb going UP - not down.

When answering this question, One Flight of Stairs = 10 steps if you know the number of steps.

❑❑ Flights per day

3. Next, we want to know how many city blocks or their equivalent you walked on average **EACH DAY** in this past week. We are only interested in walking done out of doors and walking done indoors for the sole purpose of exercise. We do not want walking done around the house or at work.

When answering this question, consider that 12 city blocks = 1 mile. If you do not know the blocks or distance, 20 minutes of walking = 12 city blocks.

❑❑ Blocks per day

4. Were there any sports, fitness, or recreational activities in which you participated during the past week? We are interested only in time that you were physically active. For example, if you lift weights only include the time that you actually are lifting the weights, not the time you spend moving from machine to machine.

***Note: All walking should only be included in Question 3**

***Note: Household activities such as cleaning and laundry are not to be included here as they are not considered to be a sport, fitness, or recreational activity.**

Sport, Fitness, or Recreation	**Times per Week**		**Average Time per Episode**
a.	❑❑		❑❑❑ Minutes
b.	❑❑		❑❑❑ Minutes
c.	❑❑		❑❑❑ Minutes
d.	❑❑		❑❑❑ Minutes

5. Would you say that during the past week (the week used for questions 2-4) you were:

- ❑ less active than usual
- ❑ more active than usual
- ❑ about as active as usual

6. At least once per week, do you engage in regular activity akin to brisk walking, jogging, bicycling, etc. long enough to work up a sweat, get your heart thumping, or get out of breath?

	❑	Yes	❑❑ times per week; Activity:	
	❑	No		

7. On a usual weekday and a weekend day, how much time (to the nearest 1 hour) do you spend on the following activities? ***The total for each day should add to 24 hours***

Sport, Fitness, or Recreation	**Usual Weekday** **Hours per Day**	**Usual Weekend Day** **Hours per Day**
b) Vigorous Activity (digging in the garden, strenuous sports, jogging, aerobic dancing, sustained swimming, brisk walking, heavy carpentry, bicycling on hills, etc.)	❑❑	❑❑
c) Moderate Activity (housework, light sports, regular walking, golf, yard work, lawn mowing, painting, repairing, light carpentry, ballroom dancing, bicycling on level ground, etc.)	❑❑	❑❑
d) Light Activity (office work, driving car, strolling, personal care, standing with little motion, etc.)	❑❑	❑❑
e) Sitting Activity (eating, reading, desk work, watching TV, computer work, listening to the radio, etc.)	❑❑	❑❑
f) Sleeping or reclining	❑❑	❑❑

WEL-Q Questionnaire

1. I can resist eating when I am anxious (nervous).

1 2 3 4 5 6 7 8 9

Not confident — Very confident

2. I can resist eating when I am depressed (or down).

1 2 3 4 5 6 7 8 9

Not confident ... Very confident

3. I can resist eating when I am angry (or irritable).

1 2 3 4 5 6 7 8 9

Not confident ... Very confident

4. I can resist eating when I have experienced failure.

1 2 3 4 5 6 7 8 9

Not confident ... Very confident

5. I can control my eating on the weekends.

1 2 3 4 5 6 7 8 9

Not confident ... Very confident

6. I can resist eating when there are many different kinds of food available.

1 2 3 4 5 6 7 8 9

Not confident ... Very confident

7. I can resist eating even when I am at a party.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

8. I can resist eating even when high-calorie foods are available.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

9. I can resist eating even when I have to say "no" to others.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

10. I can resist eating even when I feel it's impolite to refuse a second helping.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

11. I can resist eating even when others are pressuring me to eat.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

12. I can resist eating even when I think others will be upset if I don't eat.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

13. I can resist eating when I feel physically run down.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

14. I can resist eating even when I have a headache.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

15. I can resist eating when I am in pain.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

16. I can resist eating when I feel uncomfortable.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

17. I can resist eating when I am watching TV.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

18. I can resist eating when I am reading.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

19. I can resist eating just before going to bed.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

20. I can resist eating when I am happy.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

Eating Behavior Inventory

Directions: Check the number that best describes your behavior during the last 6 months.

	Never or Hardly ever	Some of the time	About half of the time	Much of the time	Always or almost always
A. I carefully watch the quantity of food that I eat.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

B. I eat foods that I believe will aid me in losing weight.	☐1	☐2	☐3	☐4	☐5
C. I keep 1 or 2 raw vegetables available for snacks.	☐1	☐2	☐3	☐4	☐5
D. I record the type and quantity of food which I eat.	☐1	☐2	☐3	☐4	☐5
E. I weigh myself daily.	☐1	☐2	☐3	☐4	☐5
F. I refuse food offered to me by others.	☐1	☐2	☐3	☐4	☐5
G. I eat quickly compared to most other people.	☐1	☐2	☐3	☐4	☐5
H. I consciously try to slow down my eating rate.	☐1	☐2	☐3	☐4	☐5
I. I eat at only one place in my home.	☐1	☐2	☐3	☐4	☐5
J. I use the same placemat and other utensils for each meal.	☐1	☐2	☐3	☐4	☐5
K (11). I eat and just can't seem to stop.	☐1	☐2	☐3	☐4	☐5
L. I eat in the middle of the night.	☐1	☐2	☐3	☐4	☐5
M. I snack after supper.	☐1	☐2	☐3	☐4	☐5
N. My emotions cause me to eat.	☐1	☐2	☐3	☐4	☐5
O. I buy ready-to-eat snack foods for myself.	☐1	☐2	☐3	☐4	☐5
P. I shop when I'm hungry.	☐1	☐2	☐3	☐4	☐5
Q. I shop from a list.	☐1	☐2	☐3	☐4	☐5
R. I leave food on my plate.	☐1	☐2	☐3	☐4	☐5
S. I serve food family style (serve from bowls on table).	☐1	☐2	☐3	☐4	☐5

T. I watch TV, read, work, or do other things while I eat.	☐1	☐2	☐3	☐4	☐5
U. If I'm served too much, I leave food on my plate.	☐1	☐2	☐3	☐4	☐5
V. Generally, while I'm at home, I leave the table as soon as I finish eating.	☐1	☐2	☐3	☐4	☐5
W. I keep a graph of my weight.	☐1	☐2	☐3	☐4	☐5
X. I eat when I'm not really hungry.	☐1	☐2	☐3	☐4	☐5
Y. I store food in containers where it is not readily visible or in a closed cupboard.	☐1	☐2	☐3	☐4	☐5
Z. I decide ahead of time what I will eat for meals and snacks.	☐1	☐2	☐3	☐4	☐5

Social Support, Eating Habits, and PA Survey

Below is a list of things people might do or say to someone who is trying to improve their eating habits and exercise regularly. We are interested in high fat and high salt (or high sodium) foods. If you are not trying to make any of these dietary changes or are not trying to exercise, then some of the questions may not apply to you, but please read and give an answer to every question.

Please rate each question *twice.* Under *family,* rate how often anyone living in your household has said or done what is described during the last three months. Under *friends,* rate how often your friends, acquaintances, or coworkers have said or done what is described **during the last three months.**

SAMPLE:

A. If my family *rarely makes fun of the foods I eat, and my friends very often* do,

I would answer like this:

A. Made fun of the foods I eat

Family Friends Online Social Network (OSN)

A. ___*2*___ A. ___*5*____ A.___*4*___

Please write *one* number from the following rating scale in each space:

none	rarely	a few times	often	very often	n/a
1	2	3	4	5	8

During the past three months, my family (or members of my household), friends, or OSN:

	Family	Friends	OSN
1. Encouraged me not to eat "unhealthy foods"	_____	_____	_____
2. Discussed my eating habit. changes with me	_____	_____	_____
3. Reminded me not to eat high fat, high salt foods.	_____	_____	_____
4. Complimented me on changing my eating habits	_____	_____	_____
5. Commented if I went back to my oId eating habits.	_____	_____	_____
6. Ate high fat or high salt foods in front of me.	_____	_____	_____
7. Refused to eat the same foods I eat.	_____	_____	_____
8. Brought home foods I'm trying not to eat.	_____	_____	_____
9. Got angry when I encouraged them to eat low salt, low fat foods.	_____	_____	_____
10. Offered me food I'm trying not to eat.	_____	_____	_____
11. Exercised with me.	_____	_____	_____
12. Offered to exercise with me.	_____	_____	_____
13. Gave me helpful reminders to exercise	_____	_____	_____
14. Gave me encouragement to stick with my exercise program.	_____	_____	_____

15. Changed their schedule so we could exercise together.	_____	_____	_____
16. Discussed exercise with me.	_____	_____	_____
17. Complained about the time I spend exercising.	_____	_____	_____
18. Criticized me or made fun of me for exercising.	_____	_____	_____
19. Gave me rewards for exercising	_____	_____	_____
20. Planned for exercise on recreational outings.	_____	_____	_____
21. Helped plan activities around my exercise.	_____	_____	_____
22. Asked me for ideas on how *they* can get more exercise	_____	_____	_____
23. Talked about how much they like to exercise.	_____	_____	_____

User Control, Cognitive Load, and Novelty

Please answer the following questions.

1. I felt like I was able to *learn at a good pace* during this study.

1 2 3 4 5 6 7

Totally Disagree Completely Agree

2. I felt like I was able to *control the order or sequence of information* I received during this study.

1 2 3 4 5 6 7

Totally Disagree Completely Agree

3. I felt like I was able to *control the content of the information* I received during this study.

1 2 3 4 5 6 7

Totally Disagree Completely Agree

4. How difficult or easy was it to process the information presented during the study?

1 2 3 4 5 6 7

Very Difficult Very Easy

5. How much mental effort did you have to spend when getting the information for this study?

1 2 3 4 5 6 7

A lot of effort Very little effort

6. I found this weight loss intervention to be very new and innovative.

1 2 3 4 5 6 7

Completely disagree Completely agree

7. I found this weight loss intervention to be very unusual and something I haven't done before.

1 2 3 4 5 6 7

Completely disagree Completely agree

Elaboration Questionnaire

Please answer the following questions on a scale of 1 (not at all) to 7 (very much).

	1-Not at all	**2**	**3**	**4**	**5**	**6**	**7-Very much**
1. How important is the topic of weight loss to you personally?	● 1-Not at all	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7-Very much
2. How motivated were you to obtain the information from this weight loss intervention?	○ 1-Not at all	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7-Very much
3. To what extent did you try hard to think about the information from this weight loss intervention?	○ 1-Not at all	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7-Very much
4. How much would you say the information from this weight loss	○ 1-Not at all	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7-Very much

	1-Not at all	**2**	**3**	**4**	**5**	**6**	**7-Very much**
intervention held your attention?							
5. How much effort would you say you gave to evaluating the information from this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
6. To what extent did you feel you had enough time to think about the information given in this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
7. To what extent did you find the information in this weight loss intervention well organized and easy to follow?	1-Not at all	2	3	4	5	6	7-Very much
8. In your opinion, how logical and accurate was the information presented in this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much

	1-Not at all	2	3	4	5	6	7-Very much
9. To what extent would you say that this intervention made good points about weight loss?	1-Not at all	2	3	4	5	6	7-Very much

Appendix D – Aim 1 Weekly Questionnaire

What is your participant ID number: ____________________

What are your initials? _________

How many podcasts did you listen to this week: ______________________

How many days during this past week did you log on to the Social POD app?

0 1 2 3 4 5 6 7

If applicable, how many times did you send a message to another user this week? ___________

If applicable, how many times did you receive a message from another user this week?
____

If you received a message from another user, did you then log on to the Social POD app to enter your weight, calorie intake, or exercise?

- Yes
- No
- Not sure/Can't remember

Did you encounter any problems while using the SocialPod app this week?

- Yes
- No

If you answered yes to the previous question, please describe in detail the problems you encountered:

____
____
____

Appendix E – Aim 1 Mid-study Focus Group Interview Guide

Instructions for Focus Group Participants: Thank you so much for attending our mid-study meeting today and completing the weekly questionnaires. The information you're providing us is very important and we appreciate and value your input. We will be recording these meetings so that we can transcribe them and use the information you provide to make improvements to the Social POD app. Because we are recording, for confidentiality please use your study ID number to identify yourself before you speak and please speak slowly, clearly, and do not talk over each other so that we can hear what everyone is saying. Results from this study may be published but you will not be identified in any way. Do you have any questions before we get started?

Semi-Structured Focus Group Questionnaire

Have you had any problems using the Social POD app?

- If so, what device are you using and please describe the problem(s) for us.

What features do you like about the Social POD app?

What features do you not like about the Social POD app?

What features could we add to the Social POD app to make it easier for you to:

- track your diet, PA, weight?
- use the messaging features of the app?
- track your weight loss?
- review information that you have entered in the app?

What features could we add to make the Social POD app better for:

- tracking your diet, PA, and weight
- sending encouraging messages to other participants to continue using the app
- tracking your weight loss
- reviewing information that you entered in the app

We are going to be adding a reward system to provide participants with rewards for using the Social POD app, what suggestions do you have for us:

- how should we set up the reward system? (like a game, points to be exchanged for prizes, etc.)
- what types of rewards should we provide? (points, stars, etc.)
- what types of prizes would you like to receive as part of a weight loss study?
-

Is there anything else that you can think of that we could add to the Social POD app to make it better?

Is there anything about the Social POD app that you would change?

- The color scheme
- Personalization (add picture, user name, etc.)
- Customization (notifications, etc.)
- Messaging system
- History
- Tracking features

Is there anything that you can think of that we could do with the Social POD app to make it different from the other weight loss apps out there?

Is there anything else that you think we should know about your experience using the app?

Appendix F – Aims 2 and 3 Participant Consent Form

Department of Health Promotion, Education, and Behavior

Arnold School of Public Health

CONSENT FORM

Refining and Pilot Testing Social Networks for Encouraging Healthy Behaviors: The Social Pounds Off Digitally (Social POD) study

Research Investigators:
Brie Turner-McGrievy, PhD, MS, RD
Sarah Hales, PhD Candidate, MSW, LMSW
Homayoun Valafar, PhD
Michael Huhns, PhD
Sara Wilcox, PhD

Introduction and Purpose

You are invited to participate in a research study conducted by Brie Turner-McGrievy, a professor in the Health Promotion, Education, and Behavior Department at the University of South Carolina. This study is funded by the University of South Carolina, Office of the Vice President for Research. You are being asked to participate in this research study because you are interested in achieving a healthy weight. The purpose of the study is to test a mobile weight loss intervention that uses a social networking smartphone application. We also aim to explore if this type of intervention produces weight loss. This form explains what you will be asked to do if you decide to participate in this study. Please read it carefully and feel free to ask any questions you like before you make a decision about participating.

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University of South Carolina
IRB Number: Pro00034960
Date Approved 5/27/2014
Version Valid Until: 5/26/2015

Are there any reasons why you should not be in this study?
You should NOT be in this study if you meet any of the following criteria:

- do not have an Android smartphone or tablet that will be in working condition for the next 3 months
- have a Body Mass Index less than 25 or greater than 49.9 kg/m^2
- are currently pregnant
- are younger than 18 or older than 65 years of age
- are unable to attend 3 meetings at the University of South Carolina
- don't have access to the Internet and a computer
- don't have access to a scale for self-monitoring weight
- aren't willing to be randomized to one of the two groups
- have a psychiatric disease, drug or alcohol dependency, or uncontrolled thyroid condition
- have a major health condition, such as heart conditions, diabetes, and past incidence of stroke
- have an eating disorder
- currently participating in a weight loss program or taking weight loss medications

Description of Study Procedures
This study involves two groups. You will be randomly assigned to one of these two groups (i.e., you do not have a choice of group assignment), which means your group will be assigned to you by chance. All groups will receive information on dietary and PA approaches aimed at losing weight via podcast. One group will be asked to track their weight, diet, and PA using a commercially available and free smartphone app that can be downloaded from the Internet. The other group will also use the commercially available apps. In addition, they will also use an Android app developed by our team, which will provide social support around weight loss.

This study will last approximately 3 months (about 12 weeks). You will need to attend one 1-1.5 hour orientation at the beginning of the study to learn more about what is involved in the study and to sign a consent form. You will then complete questionnaires on a computer at your home or other location. You will then return for a meeting where we will tell you which group you have been assigned to and we will collect your height and weight information. You will listen to 2 podcasts per week and use your phone to track your diet, weight, and exercise. Each of the podcasts will take about 15 - 20 minutes to listen to, so you should expect to spend 45 - 60 minutes each week listening to podcasts and about 5 minutes each week completing a brief survey—for a total of 1-1.25 hours per week. At the end of the 3 months, you will return for an assessment of your weight.

Below are the steps in the study:

- If you are accepted into the study, you will come to the study site (USC School of Public Health) to learn more about the study, have your weight and height measured, learn how to complete questionnaires online, and complete your consent form. This meeting will last approximately 1-1.5 hours.
- You will then complete some questionnaires that measure your diet and PA levels on a computer at home or other location where you have computer/internet access.
- You will then return to USC School of Public Health where you will learn about your group assignment, how to participate, and have your weight and height measured.
- Once you receive your group assignment, you will complete the following over the 12-week study:
  - You will download and listen to 2 podcasts per week on your smartphone, tablet, computer, or MP3 player.
  - You will track your diet, PA, and weight using your smartphone or tablet.
  - You will complete a brief, weekly questionnaire, which will provide us with feedback on how you are doing in the study and will take about 5 minutes to complete.
  - You may be assigned to a group, which will ask you to send messages to other study participants using an additional provided app for your phone or tablet. Your identity will be protected.
  - You will complete online questionnaires similar to the ones you completed at the beginning of the study at week 12.
  - You will then return to USC School of Public Health where we will obtain your weight information.
- At study completion (12 weeks), you will receive an incentive for completing all study-related assessment measures ($10).

Where and when participation occurs

Time/Task	**Location**
Orientation and Baseline Assessment	At USC School of Public Health
Baseline questionnaires	On a computer from your home or other location of your choosing
Months 0-3: Follow the weight loss diet	Weekly podcasts (2 per-week) and use of app(s) on your smartphone/tablet. Weekly surveys completed on a computer from your home or other location of your choosing.
3-month questionnaires	On a computer from your home or other location of your choosing
3-month weight assessment	At USC School of Public Health

Study Measures

At each time point (baseline and the end of 3 months); we will measure your weight and height. In addition, we will ask you to complete questionnaires on eating behaviors. These questionnaires may include some sensitive or personal information (such as your age, ethnicity, and questions about your eating habits and preferences). We will also ask you to report everything you ate or drank over the previous 24 hours on 2 separate, but unannounced, days at the beginning and end of the study. These dietary "recalls" will be reported using an online dietary data collection site developed by the National Cancer Institute.

Risks of Participation

Risks of participating in this research study are minimal. We will collect some personal information about your health and dietary habits during the study, but these will be identified only with a number (not your name), and will be stored on a password-protected server. A potential risk of participating in the study is the loss of confidentiality of your protected health information; however, study staff will store all electronic documents on password-protected servers and all paper documents in a locked cabinet in a locked office at the University of South Carolina.

Benefits of Participation

This research study is designed to benefit society by gaining new knowledge about the use of mobile phones to help provide support during a weight loss intervention. The benefits to you from being in this study may be, learning new information about healthy eating. You may also lose weight, which may help to reduce your risk of developing chronic diseases such as diabetes, some forms of cancer, or heart disease. In addition, you may learn new and healthy cooking tips as well as tips for dining out.

Costs

It will not cost you anything to be in this study. You will be responsible for your transportation costs for the 2-3 total visits that you will have at the USC School of Public Health.

Payments

You will receive a total of $10 for completion of all study-related assessment measures at the end of 3-months.

Circumstances for Dismissal from the Study

You may be dismissed from the study without your consent for the following reasons:

- If you do not keep appointments for study visits or fail to complete study activities (e.g. failure to complete forms).
- If you do not follow the instructions you are given.
- If the investigator believes, that it is not in your best interest to continue in the study.
- If you become pregnant.

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Confidentiality of Records

Participation will be confidential. A number will be assigned to each participant at the beginning of the project. This number will be used on project records rather than your name, and no one other than the research investigators will be able to link your information with your name. Study records/data will be stored in locked filing cabinets and protected computer files at the University of South Carolina. Electronic data obtained through online surveys or transmitted by your mobile phone will be stored on a secure, password-protected server. This information will not contain your name. You will be assigned a participant number to use on your surveys and you may choose a username for the social network, which does not identify you (e.g., you may choose a pseudonym/made up name). The results of the study may be published or presented at professional meetings, but your identity will not be revealed. While we will make every effort to protect your privacy, it cannot be guaranteed absolutely. In rare cases, a research study may be evaluated by an oversight agency, such as the U.S. Office for Human Research Protections, or the Office of Research Compliance at the University of South Carolina. If this occurs, records that identify you, and the consent form signed by you, may be inspected to evaluate whether the study is/has been properly conducted, and that the rights of participants are/were adequately protected.

Contact Persons

For more information concerning this research study, or if you believe you may have suffered a research related injury, you should contact Dr. Brie Turner-McGrievy at (803) 777-3932 or e-mail brie@sc.edu.

If you have any questions about your rights as a research subject contact, Lisa Marie Johnson, IRB Manager, Office of Research Compliance, University of South Carolina, 901 Sumter Street, Byrnes 515, Columbia, SC 29208, Phone: (803) 777-7095 or LisaJ@mailbox.sc.edu. The Office of Research Compliance is an administrative office that supports the USC Institutional Review Board. The Institutional Review Board (IRB) consists of representatives from a variety of scientific disciplines, non-scientists, and community members for the primary purpose of protecting the rights and welfare of human subjects enrolled in research studies.

Voluntary Participation

Participation in this study is voluntary. You are free not to participate or to withdraw at any time, for whatever reason, without negative consequences. In the event that you do withdraw from this study, the information you have already provided will be kept in a confidential manner.

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Signatures/Dates *of participant*

I have read (or have had read to me) the contents of this consent form and have been encouraged to ask questions. I have received answers to my questions. I give my consent to participate in this study. I have been told that I may withdraw at any time without negative consequences. I have received (or will receive) a copy of this form for my records and future reference.

_______________________________________ ______________

Signature of Research Subject Date

____

Printed Name of Research Subject

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Appendix G – Aims 2 and 3 Pre-study Questionnaire

Demographic Questionnaire (only administered at baseline)

1. Participant number__________

2. Your initials: __________

3. Age: _______________

4. Height: ______________

5. Weight: ______________

6. Gender (select one): MaleFemale

7. Are you Hispanic or Latino: Yes   No

8. Ethnicity (select one):

   a. American Indian or Alaska Native

   b. Asian

   c. Black or African American

   d. Native Hawaiian or Other Pacific Islander

   e. White

9. Education (select one):

   a. 8th grade or less

   b. Some high school

   c. High school diploma or equivalent

d. Some college

e. College degree or equivalent

f. Advanced degree (Masters, doctoral, or other post-college degree)

10. What is your present work status?

a. Working full-time

b. Working part-time

c. Homemaker

d. Student

e. Retired

f. Unable to work or disabled Out of work

G. Out of work

H. Other

11. Which of the following <u>best</u> describes your <u>current</u> marital status?

a. Never Married

b. Living with a partner

c. Married

d. Separated

e. Divorced

f. Widowed

g. Don't Know

h. Refused

12. Do you own an Android internet-capable mobile phone (select one)? Yes No

a. If yes, for how long? (enter number of months and/or years):

____

b. What kind do you have (what brand and model)?

____

13. Have you ever downloaded a podcast before (circle one):

a. Yes

b. No

c. I don't know

14. Have you downloaded a health-related podcast before, such as one that promotes healthy eating, weight loss, or exercise?

aYes

b. No

c. I don't know

15. Have you ever installed an application ("app") to your internet mobile device to help you eat better?

a. Yes (If yes, please list all) ________________________

b. No

c. I don't know

16. Have you ever installed an application ("app") to your internet mobile device to help you improve your PA?

a. Yes (If yes, please list which ones)

b. No

c. I don't know

17. How many hours a day do you spend online on a computer? ______________________

18. Are you a member of any social networking sites (such as Twitter, Facebook, Instagram, LinkedIn, etc.)?

a. Yes (If Yes, go to question 19)

b. No (end of demographics survey)

19. Please select all of the social networking sites of which you are currently a member:

a. Facebook

b. MySpace

c. Twitter

d. Friendster

e. Flixster

f. Tagged

g. LinkedIn

h. Classmates.com

i. LiveJournal

j. Instagram

k. Pinterest

l. Other (please list all) ______________________________

20. Which of the following wearable fitness tracking devices you currently use:

a. FitBit

b. Jawbone

c. Fuel Band

d. General pedometer

e. Heath-monitoring watch

f. Garmin

g. Other (please list all)

h. I don't currently use a wearable fitness tracking device

Stanford Expectations of Treatment Scale (SETS) Baseline

The following questions are about the weight loss program you will soon receive. We want to know how you think you will respond to this program. Please indicate how much you agree with each statement by choosing the appropriate number. For example, if you strongly disagree with a statement, fill in the circle on the far left. If you strongly agree with the statement, fill in the circle on the far right. Your responses to these questions will not affect your status in the program in any way. We realize it may be difficult to guess how you will respond to a new weight loss program. If you are unsure about any statement please give the best guess you can. There are no right or wrong answers.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Agree Nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree
o	o	o	o	o	o	o

1. This program will be completely effective	o	o	o	o	o	o	o
2. I am worried about this program	o	o	o	o	o	o	o
3. My condition will be completely resolved after this program	o	o	o	o	o	o	o
4. I have fears about this program	o	o	o	o	o	o	o
5. I have complete confidence in this program	o	o	o	o	o	o	o

6. I am nervous about

the negative effects

of this program ○ ○ ○ ○ ○ ○ ○

Motivational Predisposition for Weight Loss

We would like to know more about what motivates you. Different people have different reasons for losing weight and we want to know how true each of these reasons is for you. Please tell me how true each reason is for you by picking a number between one to seven, with one being "Strongly Disagree" and seven being "Strongly Agree."

Question stem (for all questions – needs to be visible when answering all questions in this scale)

"A reason that I would lose weight is…"

1. Because it is important for being as healthy as possible. **[IMHealthy]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

2. Because I would like to improve my physical health. **[IMImpPhysical]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

3. Because I personally believe it is a good thing for my health. **[IMGoodThing]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

4. Because I want to take responsibility for my own health. **[IMResp]**

1	2	3	4	5	6	7

Strongly Disagree | | | | | | Strongly Agree

5. Because I have carefully thought about it and believe it is very important for me. **[IMImport]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

6. Because it is an important choice I really want to make. **[IMChoice]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

7. Because I have a <u>strong value</u> for losing weight. **[IMValue]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

8. Because I would feel better about myself if I did lose weight. **[IMFeelBetter]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

9. Because I want to feel in control of my health. **[IMControl]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

10. Because it is consistent with my life goals. **[IMLifeGoals]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

11. Because I want others to see I can do it. **[EMOtherSee]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

12. Because I don't want to let others down. **[EMNoLetDown]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

13. Because I want others to approve of me. **[EMOtherApprv]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

14. Because I feel pressure from others to lose weight. **[EMPressure]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

15. Because others would be upset with me if I did not. **[EMOtherUpset]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

16. Because my family pressures me to lose weight. **[EMFamPres]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

17. Because I would feel guilty or ashamed of myself if I did not. **[EMIGuilty]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

18. Because it is easier to do what I am told than to think about it. **[EMTold]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

19. Because I would feel bad about myself if I did not. **[EMIFeelBad]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

20. Because I want to set a good example for my community. **[EMGdExCom]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

21. Because I want to set a good example for my family. **[EMGdExFam]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

22. If I don’t start losing weight, I know I’ll regret it. **[EMIRegret]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

Paffenbarger Questionnaire: EXERCISE HABITS

1. Was there anything about the past week that made exercising especially different for you in terms of extended illness, injury, or vacation?

❑ 1 Yes — If “YES”, please complete this questionnaire about the previous week.

❑ 2 No — If “NO”, please complete this questionnaire about this past week.

2. First, we are interested in the number of flights of stairs you climbed on average **EACH DAY** in this past week. We only want to know the number of flights you climb going _UP_ - not down.

***When answering this question, One Flight of Stairs = 10 steps if you know the number of steps.**

❑❑ Flights per day

3. Next, we want to know how many city blocks or their equivalent you walked on average **EACH DAY** in this past week. We are only interested in walking done out of doors and walking done indoors for the sole purpose of exercise. We do not want walking done around the house or at work.

***When answering this question, consider that 12 city blocks = 1 mile. If you do not know the blocks or distance, 20 minutes of walking = 12 city blocks.**

❑❑ Blocks per day

4. Were there any sports, fitness, or recreational activities in which you participated during the past week? We are interested only in time that you were physically active. For example, if you lift weights only include the time that you actually are lifting the weights, not the time you spend moving from machine to machine.

***Note: All walking should only be included in Question 3**

***Note: Household activities such as cleaning and laundry are not to be included here as they are not considered to be a sport, fitness, or recreational activity.**

Sport, Fitness, or Recreation	Times per Week		Average Time per Episode
a.	❑❑		❑❑❑ Minutes
b.	❑❑		❑❑❑ Minutes
c.	❑❑		❑❑❑ Minutes
d.	❑❑		❑❑❑ Minutes

5. Would you say that during the past week (the week used for questions 2-4) you were:

- ❑ less active than usual
- ❑ more active than usual
- ❑ about as active as usual

6. At least once per week, do you engage in regular activity akin to brisk walking, jogging, bicycling, etc. long enough to work up a sweat, get your heart thumping, or get out of breath?

	❑	Yes	❑❑ times per week; Activity:	
	❑	No		

7. On a usual weekday and a weekend day, how much time (to the nearest 1 hour) do you spend on the following activities? ***The total for each day should add to 24 hours***

Sport, Fitness, or Recreation	**Usual Weekday** **Hours per Day**	**Usual Weekend Day** **Hours per Day**
c) Vigorous Activity (digging in the garden, strenuous sports, jogging, aerobic dancing, sustained swimming, brisk walking, heavy carpentry, bicycling on hills, etc.)	❑❑	❑❑
d) Moderate Activity (housework, light sports, regular walking, golf, yard work, lawn mowing, painting, repairing, light carpentry, ballroom dancing, bicycling on level ground, etc.)	❑❑	❑❑
e) Light Activity (office work, driving car, strolling, personal care, standing with little motion, etc.)	❑❑	❑❑
f) Sitting Activity (eating, reading, desk work, watching TV, computer work, listening to the radio, etc.)	❑❑	❑❑
g) Sleeping or reclining	❑❑	❑❑

WEL-Q Questionnaire

1. I can resist eating when I am anxious (nervous).

1 2 3 4 5 6 7 8 9

Not confident — Very confident

2. I can resist eating when I am depressed (or down).

1	2	3	4	5	6	7	8	9
Not confident								Very confident

3. I can resist eating when I am angry (or irritable).

1	2	3	4	5	6	7	8	9
Not confident								Very confident

4. I can resist eating when I have experienced failure.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

5. I can control my eating on the weekends.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

6. I can resist eating when there are many different kinds of food available.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

7. I can resist eating even when I am at a party.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

8. I can resist eating even when high-calorie foods are available.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

9. I can resist eating even when I have to say "no" to others.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

10. I can resist eating even when I feel it's impolite to refuse a second helping.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

11. I can resist eating even when others are pressuring me to eat.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

12. I can resist eating even when I think others will be upset if I don't eat.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

13. I can resist eating when I feel physically run down.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

14. I can resist eating even when I have a headache.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

15. I can resist eating when I am in pain.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

16. I can resist eating when I feel uncomfortable.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

17. I can resist eating when I am watching TV.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

18. I can resist eating when I am reading.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

19. I can resist eating just before going to bed.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

20. I can resist eating when I am happy.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

Eating Behavior Inventory

Directions: Check the number that best describes your behavior during the last 6 months.

	Never or Hardly ever	Some of the time	About half of the time	Much of the time	Always or almost always
A. I carefully watch the quantity of food that I eat.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

B. I eat foods that I believe will aid me in losing weight.	☐1	☐2	☐3	☐4	☐5
C. I keep 1 or 2 raw vegetables available for snacks.	☐1	☐2	☐3	☐4	☐5
D. I record the type and quantity of food which I eat.	☐1	☐2	☐3	☐4	☐5
E. I weigh myself daily.	☐1	☐2	☐3	☐4	☐5
F. I refuse food offered to me by others.	☐1	☐2	☐3	☐4	☐5
G. I eat quickly compared to most other people.	☐1	☐2	☐3	☐4	☐5
H. I consciously try to slow down my eating rate.	☐1	☐2	☐3	☐4	☐5
I. I eat at only one place in my home.	☐1	☐2	☐3	☐4	☐5
J. I use the same placemat and other utensils for each meal.	☐1	☐2	☐3	☐4	☐5
K (11). I eat and just can't seem to stop.	☐1	☐2	☐3	☐4	☐5
L. I eat in the middle of the night.	☐1	☐2	☐3	☐4	☐5
M. I snack after supper.	☐1	☐2	☐3	☐4	☐5
N. My emotions cause me to eat.	☐1	☐2	☐3	☐4	☐5
O. I buy ready-to-eat snack foods for myself.	☐1	☐2	☐3	☐4	☐5
P. I shop when I'm hungry.	☐1	☐2	☐3	☐4	☐5
Q. I shop from a list.	☐1	☐2	☐3	☐4	☐5
R. I leave food on my plate.	☐1	☐2	☐3	☐4	☐5
S. I serve food family style (serve from bowls on table).	☐1	☐2	☐3	☐4	☐5

T. I watch TV, read, work, or do other things while I eat.	☐1	☐2	☐3	☐4	☐5
U. If I'm served too much, I leave food on my plate.	☐1	☐2	☐3	☐4	☐5
V. Generally, while I'm at home, I leave the table as soon as I finish eating.	☐1	☐2	☐3	☐4	☐5
W. I keep a graph of my weight.	☐1	☐2	☐3	☐4	☐5
X. I eat when I'm not really hungry.	☐1	☐2	☐3	☐4	☐5
Y. I store food in containers where it is not readily visible or in a closed cupboard.	☐1	☐2	☐3	☐4	☐5
Z. I decide ahead of time what I will eat for meals and snacks.	☐1	☐2	☐3	☐4	☐5

Social Support, Eating Habits, and PA Survey

Below is a list of things people might do or say to someone who is trying to improve their eating habits and exercise regularly. We are interested in high fat and high salt (or high sodium) foods. If you are not trying to make any of these dietary changes or are not trying to exercise, then some of the questions may not apply to you, but please read and give an answer to every question.

Please rate each question *twice.* Under *family,* rate how often anyone living in your household has said or done what is described during the last three months. Under *friends,* rate how often your friends, acquaintances, or coworkers have said or done what is described **during the last three months.**

SAMPLE:

A. If my family *rarely makes fun of the foods I eat, and my friends very often* do,

I would answer like this:

A. Made fun of the foods I eat

Family Friends Online Social Network (OSN)

A. ___*2*___ A. ___*5*____ A.___*4*___

Please write *one* number from the following rating scale in each space:

none	rarely	a few times	often	very often	n/a
1	2	3	4	5	8

During the past three months, my family (or members of my household), friends, or OSN:

	Family	Friends	OSN
1. Encouraged me not to eat "unhealthy foods"	_____	_____	_____
2. Discussed my eating habit. changes with me	_____	_____	_____
3. Reminded me not to eat high fat, high salt foods.	_____	_____	_____
4. Complimented me on changing my eating habits	_____	_____	_____
5. Commented if I went back to my oId eating habits.	_____	_____	_____
6. Ate high fat or high salt foods in front of me.	_____	_____	_____
7. Refused to eat the same foods I eat.	_____	_____	_____
8. Brought home foods I'm trying not to eat.	_____	_____	_____
9. Got angry when I encouraged them to eat low salt, low fat foods.	_____	_____	_____
10. Offered me food I'm trying not to eat.	_____	_____	_____
11. Exercised with me.	_____	_____	_____
12. Offered to exercise with me.	_____	_____	_____
13. Gave me helpful reminders to exercise	_____	_____	_____
14. Gave me encouragement to stick with my exercise program.	_____	_____	_____

15. Changed their schedule so we could exercise together.	_____	_____	_____
16. Discussed exercise with me.	_____	_____	_____
17. Complained about the time I spend exercising.	_____	_____	_____
18. Criticized me or made fun of me for exercising.	_____	_____	_____
19. Gave me rewards for exercising	_____	_____	_____
20. Planned for exercise on recreational outings.	_____	_____	_____
21. Helped plan activities around my exercise.	_____	_____	____
22. Asked me for ideas on how *they* can get more exercise	_____	_____	_____
23. Talked about how much they like to exercise.	_____	_____	_____

English Big Five Inventory (administered at baseline)

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others?

Directions: Please choose a number for each statement to indicate the extent to which you agree or disagree with that statement.

1: Disagree strongly

2: Disagree a little

3: Neither agree nor disagree

4: Agree a little

5: Agree strongly

I see myself as someone who . . .

1. is talkative_____

2. tends to find fault with others_____

3. does a thorough job_____

4. is depressed, blue_____

5. is original, comes up with new ideas_____

6. is reserved_____

7. is helpful and unselfish with others_____

8. can be somewhat careless_____

9. is relaxed, handles stress well_____

10. is curious about many different things_____

11. is full of energy_____

12. starts quarrels with others_____

13. is a reliable worker_____

14, can be tense_____

15. is ingenious, a deep thinker_____

16. generates a lot of enthusiasm_____

17. has a forgiving nature_____

18. tends to be disorganized_____

19. worries a lot_____

20. has an active imagination_____

21. tends to be quiet_____

22. is generally trusting______

23. tends to be lazy_____

24. is emotionally stable, not easily upset_____

25. is inventive_____

26. has an assertive personality_____

27. can be cold and aloof_____

28. perseveres until die task is finished_____

29. can be moody_____

30. values artistic, aesthetic experiences

31. is sometimes shy, inhibited_____

32. is considerate and kind to almost everyone_____

33. does things efficiently_____

34. remains calm in tense situations_____

35. prefers work that is routine_____

36. is outgoing, sociable_____

37. is sometimes rude to others_____

38. makes plans and follows through with them_____

39. gets nervous easily_____

40. likes to reflect, play with ideas_____

41. has few artistic interests_____

42. likes to cooperate with others_____

43. is easily distracted_____

44. is sophisticated in art, music, or literature_____

APPENDIX H – AIMS 2 AND 3 POST-STUDY QUESTIONNAIRE

Thank you so much for your participation in the Social POD Study. Please complete the end of study survey below.

Participant ID:

Initials:

Stanford Expectations of Treatment Scale (SETS) End of Study

The following questions are about the weight loss program you have received. We want to know how you responded to this program. Please indicate how much you agree with each statement by choosing the appropriate number. For example, if you strongly disagree with a statement, fill in the circle on the far left. If you strongly agree with the statement, fill in the circle on the far right. Your responses to these questions will not affect your status in the program in any way. If you are unsure about any statement please give the best guess you can. There are no right or wrong answers.

Strongly Disagree	Moderately Disagree	Slightly Disagree	Neither Agree Nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree
o	o	o	o	o	o	o

1. This program will be completely effective	o	o	o	o	o	o	o
2. I am worried about this program	o	o	o	o	o	o	o

3. My condition will be completely resolved after this program	o o o o o o o
4. I have fears about this program	o o o o o o o
5. I have complete confidence in this program	o o o o o o o
6. I am nervous about the negative effects of this program	o o o o o o o

Motivational Predisposition for Weight Loss

We would like to know more about what motivates you. Different people have different reasons for losing weight and we want to know how true each of these reasons is for you. Please tell me how true each reason is for you by picking a number between one to seven, with one being "Strongly Disagree" and seven being "Strongly Agree."

Question stem (for all questions – needs to be visible when answering all questions in this scale)

"A reason that I would lose weight is…"

1. Because it is important for being as healthy as possible. **[IMHealthy]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

2. Because I would like to improve my physical health. **[IMImpPhysical]**

1 2 3 4 5 6 7

Strongly Disagree — Strongly Agree

3. Because I personally believe it is a good thing for my health. **[IMGoodThing]**

1 2 3 4 5 6 7

Strongly Disagree — Strongly Agree

4. Because I want to take responsibility for my own health. **[IMResp]**

1 2 3 4 5 6 7

Strongly Disagree — Strongly Agree

5. Because I have carefully thought about it and believe it is very important for me. **[IMImport]**

1 2 3 4 5 6 7

Strongly Disagree — Strongly Agree

6. Because it is an important choice I really want to make. **[IMChoice]**

1 2 3 4 5 6 7

Strongly Disagree — Strongly Agree

7. Because I have a strong value for losing weight. **[IMValue]**

1 2 3 4 5 6 7

Strongly — Strongly

Disagree Agree

8. Because I would feel better about myself if I did lose weight. **[IMFeelBetter]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

9. Because I want to feel in control of my health. **[IMControl]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

10. Because it is consistent with my life goals. **[IMLifeGoals]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

11. Because I want others to see I can do it. **[EMOtherSee]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

12. Because I don’t want to let others down. **[EMNoLetDown]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

13. Because I want others to approve of me. **[EMOtherApprv]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

14. Because I feel pressure from others to lose weight. **[EMPressure]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

15. Because others would be upset with me if I did not. **[EMOtherUpset]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

16. Because my family pressures me to lose weight. **[EMFamPres]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

17. Because I would feel guilty or ashamed of myself if I did not. **[EMIGuilty]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

18. Because it is easier to do what I am told than to think about it. **[EMTold]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

19. Because I would feel bad about myself if I did not. **[EMIFeelBad]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

20. Because I want to set a good example for my community. **[EMGdExCom]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

21. Because I want to set a good example for my family. **[EMGdExFam]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

22. If I don't start losing weight, I know I'll regret it. **[EMIRegret]**

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

Paffenbarger Questionnaire: EXERCISE HABITS

---

1. Was there anything about the past week that made exercising especially different for you in terms of extended illness, injury, or vacation?

☐ 1 Yes — If "YES", please complete this questionnaire about the previous week.

☐ 2 No — If "NO", please complete this questionnaire about this past week.

---

2. First, we are interested in the number of flights of stairs you climbed on average **EACH DAY** in this past week. We only want to know the number of flights you climb going _UP_ - not down.

When answering this question, One Flight of Stairs = 10 steps if you know the number of steps.

❑❑ Flights per day

3. Next, we want to know how many city blocks or their equivalent you walked on average **EACH DAY** in this past week. We are only interested in walking done out of doors and walking done indoors for the sole purpose of exercise. We do not want walking done around the house or at work.

When answering this question, consider that 12 city blocks = 1 mile. If you do not know the blocks or distance, 20 minutes of walking = 12 city blocks.

❑❑ Blocks per day

4. Were there any sports, fitness, or recreational activities in which you participated during the past week? We are interested only in time that you were physically active. For example, if you lift weights only include the time that you actually are lifting the weights, not the time you spend moving from machine to machine.

***Note: All walking should only be included in Question 3**

***Note: Household activities such as cleaning and laundry are not to be included here as they are not considered to be a sport, fitness, or recreational activity.**

Sport, Fitness, or Recreation	**Times per Week**		**Average Time per Episode**
a.	❑❑		❑❑❑ Minutes
b.	❑❑		❑❑❑ Minutes
c.	❑❑		❑❑❑ Minutes
d.	❑❑		❑❑❑ Minutes

5. Would you say that during the past week (the week used for questions 2-4) you were:

❑ less active than usual

❑ more active than usual

❑ about as active as usual

6. At least once per week, do you engage in regular activity akin to brisk walking, jogging, bicycling, etc. long enough to work up a sweat, get your heart thumping, or get out of breath?				
	❑	Yes	❑❑ times per week; Activity:	
	❑	No		

7. On a usual weekday and a weekend day, how much time (to the nearest 1 hour) do you spend on the following activities? ***The total for each day should add to 24 hours***

Sport, Fitness, or Recreation	**Usual Weekday** **Hours per Day**	**Usual Weekend Day** **Hours per Day**
d) Vigorous Activity (digging in the garden, strenuous sports, jogging, aerobic dancing, sustained swimming, brisk walking, heavy carpentry, bicycling on hills, etc.)	❑❑	❑❑
e) Moderate Activity (housework, light sports, regular walking, golf, yard work, lawn mowing, painting, repairing, light carpentry, ballroom dancing, bicycling on level ground, etc.)	❑❑	❑❑
f) Light Activity (office work, driving car, strolling, personal care, standing with little motion, etc.)	❑❑	❑❑
g) Sitting Activity (eating, reading, desk work, watching TV, computer work, listening to the radio, etc.)	❑❑	❑❑
h) Sleeping or reclining	❑❑	❑❑

WEL-Q Questionnaire

1. I can resist eating when I am anxious (nervous).

1	2	3	4	5	6	7	8	9
Not confident								Very confident

2. I can resist eating when I am depressed (or down).

1	2	3	4	5	6	7	8	9
Not confident								Very confident

3. I can resist eating when I am angry (or irritable).

1	2	3	4	5	6	7	8	9
Not confident								Very confident

4. I can resist eating when I have experienced failure.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

5. I can control my eating on the weekends.

1	2	3	4	5	6	7	8	9
Not								Very

confident	confident

6. I can resist eating when there are many different kinds of food available.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

7. I can resist eating even when I am at a party.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

8. I can resist eating even when high-calorie foods are available.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

9. I can resist eating even when I have to say "no" to others.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

10. I can resist eating even when I feel it's impolite to refuse a second helping.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

11. I can resist eating even when others are pressuring me to eat.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

12. I can resist eating even when I think others will be upset if I don't eat.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

13. I can resist eating when I feel physically run down.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

14. I can resist eating even when I have a headache.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

15. I can resist eating when I am in pain.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

16. I can resist eating when I feel uncomfortable.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

17. I can resist eating when I am watching TV.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

18. I can resist eating when I am reading.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

19. I can resist eating just before going to bed.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

20. I can resist eating when I am happy.

1	2	3	4	5	6	7	8	9
Not confident								Very confident

Eating Behavior Inventory

Directions: Check the number that best describes your behavior during the last 6 months.

	Never or Hardly ever	Some of the time	About half of the time	Much of the time	Always or almost always
A. I carefully watch the quantity of food that I eat.	☐1	☐2	☐3	☐4	☐5
B. I eat foods that I believe will aid me in losing weight.	☐1	☐2	☐3	☐4	☐5
C. I keep 1 or 2 raw vegetables available for snacks.	☐1	☐2	☐3	☐4	☐5
D. I record the type and quantity of food which I eat.	☐1	☐2	☐3	☐4	☐5
E. I weigh myself daily.	☐1	☐2	☐3	☐4	☐5
F. I refuse food offered to me by others.	☐1	☐2	☐3	☐4	☐5
G. I eat quickly compared to most other people.	☐1	☐2	☐3	☐4	☐5
H. I consciously try to slow down my eating rate.	☐1	☐2	☐3	☐4	☐5
I. I eat at only one place in my home.	☐1	☐2	☐3	☐4	☐5
J. I use the same placemat and other utensils for each meal.	☐1	☐2	☐3	☐4	☐5
K (11). I eat and just can't seem to stop.	☐1	☐2	☐3	☐4	☐5
L. I eat in the middle of the night.	☐1	☐2	☐3	☐4	☐5
M. I snack after supper.	☐1	☐2	☐3	☐4	☐5
N. My emotions cause me to eat.	☐1	☐2	☐3	☐4	☐5
O. I buy ready-to-eat snack foods for myself.	☐1	☐2	☐3	☐4	☐5

P. I shop when I'm hungry.	☐1	☐2	☐3	☐4	☐5
Q. I shop from a list.	☐1	☐2	☐3	☐4	☐5
R. I leave food on my plate.	☐1	☐2	☐3	☐4	☐5
S. I serve food family style (serve from bowls on table).	☐1	☐2	☐3	☐4	☐5
T. I watch TV, read, work, or do other things while I eat.	☐1	☐2	☐3	☐4	☐5
U. If I'm served too much, I leave food on my plate.	☐1	☐2	☐3	☐4	☐5
V. Generally, while I'm at home, I leave the table as soon as I finish eating.	☐1	☐2	☐3	☐4	☐5
W. I keep a graph of my weight.	☐1	☐2	☐3	☐4	☐5
X. I eat when I'm not really hungry.	☐1	☐2	☐3	☐4	☐5
Y. I store food in containers where it is not readily visible or in a closed cupboard.	☐1	☐2	☐3	☐4	☐5
Z. I decide ahead of time what I will eat for meals and snacks.	☐1	☐2	☐3	☐4	☐5

Social Support, Eating Habits, and PA Survey

Below is a list of things people might do or say to someone who is trying to improve their eating habits and exercise regularly. We are interested in high fat and high salt (or high sodium) foods. If you are not trying to make any of these dietary changes or are not trying to exercise, then some of the questions may not apply to you, but please read and give an answer to every question.

Please rate each question *twice.* Under *family,* rate how often anyone living in your household has said or done what is described during the last three months. Under *friends,* rate how often your friends, acquaintances, or coworkers have said or done what is described **during the last three months.**

SAMPLE:

A. If my family *rarely makes fun of the foods I eat, and my friends very often* do,

I would answer like this:

A. Made fun of the foods I eat

Family Friends Online Social Network (OSN)

A. ___*2*___ A. ___*5*____A.___*4*___

Please write *one* number from the following rating scale in each space:

none	rarely	a few times	often	very often	n/a
1	2	3	4	5	8

During the past three months, my family (or members of my household), friends, or OSN:

	Family	Friends	OSN
1. Encouraged me not to eat "unhealthy foods"	_____	_____	_____
2. Discussed my eating habit. changes with me	_____	_____	_____
3. Reminded me not to eat high fat, high salt foods.	_____	_____	_____
4. Complimented me on changing my eating habits	_____	_____	_____
5. Commented if I went back to my old eating habits.	_____	_____	_____
6. Ate high fat or high salt foods in front of me.	_____	_____	_____
7. Refused to eat the same foods I eat.	_____	_____	_____
8. Brought home foods I'm trying not to eat.	_____	_____	_____
9. Got angry when I encouraged them to eat low salt, low fat foods.	_____	_____	_____

10. Offered me food I'm trying not to eat.	_____	_____	_____
11. Exercised with me.	_____	_____	_____
12. Offered to exercise with me.	_____	_____	_____
13. Gave me helpful reminders to exercise	_____	_____	_____
14. Gave me encouragement to stick with my exercise program.	_____	_____	_____
15. Changed their schedule so we could exercise together.	_____	_____	_____
16. Discussed exercise with me.	_____	_____	_____
17. Complained about the time I spend exercising.	_____	_____	_____
18. Criticized me or made fun of me for exercising.	_____	_____	_____
19. Gave me rewards for exercising	_____	_____	_____
20. Planned for exercise on recreational outings.	_____	_____	_____
21. Helped plan activities around my exercise.	_____	_____	_____
22. Asked me for ideas on how *they* can get more exercise	_____	_____	_____
23. Talked about how much they like to exercise.	_____	_____	_____

User Control, Cognitive Load, and Novelty

Please answer the following questions.

1. I felt like I was able to *learn at a good pace* during this study.

1 2 3 4 5 6 7

Totally Disagree Completely Agree

2. I felt like I was able to *control the order or sequence of information* I received during this study.

1 2 3 4 5 6 7

Totally Disagree Completely Agree

3. I felt like I was able to *control the content of the information* I received during this study.

1 2 3 4 5 6 7

Totally Disagree Completely Agree

4. How difficult or easy was it to process the information presented during the study?

1 2 3 4 5 6 7

Very Difficult Very Easy

5. How much mental effort did you have to spend when getting the information for this study?

1 2 3 4 5 6 7

A lot of effort Very little effort

6. I found this weight loss intervention to be very new and innovative.

1 2 3 4 5 6 7

Completely disagree Completely agree

7. I found this weight loss intervention to be very unusual and something I haven't done before.

1 2 3 4 5 6 7

Completely disagree Completely agree

Elaboration Questionnaire

Please answer the following questions on a scale of 1 (not at all) to 7 (very much).

	1-Not at all	**2**	**3**	**4**	**5**	**6**	**7-Very much**
1. How important is the topic of weight loss to you personally?	1-Not at all	2	3	4	5	6	7-Very much
2. How motivated were you to obtain the information from this weight	1-Not at all	2	3	4	5	6	7-Very much

	1-Not at all	2	3	4	5	6	7-Very much
loss intervention?							
3. To what extent did you try hard to think about the information from this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
4. How much would you say the information from this weight loss intervention held your attention?	1-Not at all	2	3	4	5	6	7-Very much
5. How much effort would you say you gave to evaluating the information from this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
6. To what extent did you feel you had enough time to think about the information given in this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
7. To what extent did you find the information in this	1-Not at all	2	3	4	5	6	7-Very

	1-Not at all	2	3	4	5	6	7-Very much
weight loss intervention well organized and easy to follow?							much
8. In your opinion, how logical and accurate was the information presented in this weight loss intervention?	1-Not at all	2	3	4	5	6	7-Very much
9. To what extent would you say that this intervention made good points about weight loss?	1-Not at all	2	3	4	5	6	7-Very much

Process Evaluation

1. I found that accessing the information was very easy.

1 2 3 4 5 6 7

Totally disagree Completely agree

2. I found that accessing the information for the study was an effective way to get information about weight loss.

1 2 3 4 5 6 7

Totally disagree Completely agree

3. I enjoyed participating in this study.

1 2 3 4 5 6 7

Totally disagree Completely agree

4. I felt that I was able to provide support to other participants as a result of this study.

1 2 3 4 5 6 7

Totally disagree Completely agree

5. I felt that I received adequate support from other participants as a result of this study.

1 2 3 4 5 6 7

Totally disagree Completely agree

6. On average, how often did you listen to the podcasts during the past 3 months?

a. never

b. once a month

c. once a week

d. 2 times a week

e. greater than 2 times per week

7. How many podcasts total did you listen to during the past 3 months (out of 24 possible podcasts provided to you)? ___________

8. What device did you use the most to listen to your podcasts?

a. iPod (iPhone, iPod Touch, Nano, etc.)

b. BlackBerry

c. Google Android-based phone

d. Other MP3 player

e. Directly on computer

f. Other (please list): ____________________

9. Please select the smartphone that you used primarily for this study?

a. Palm Pre

b. BlackBerry

c. My own Android-based phone

d. iPhone

e. Other (please list): _____________

10. Please select the tablet that you used primarily for this study?

a. My own Android-based tablet

b. iPad

c. Study provided Android based tablet

e. Other (please list): ___________

11. Did you download any applications “apps” to your smartphone or tablet over the past 3 months?

a. Yes (If Yes, go to #12)

b. No (go to 16)

12. Did you download any apps related to tracking your dietary intake, such as a calorie-counting app?

a. Yes (Go to question 13)

b. No (go to 14)

13. Which of the following apps did you download to track your dietary intake (select all that apply):

a. My Fitness Pal

b. Lose It

c. Fat Secret

d. Noom Coach

e. My Diet Coach

f. Weight Watchers

g. Other (please list):________________

14. Did you download any apps related to tracking your PA?

a. Yes. (Go to question 15)

b. No (go to 16)

15. Which of the following apps did you download to track your PA (select all that apply):

a. Nexercise

b. Map My Run

c. My Fitness Pal

d. Lose It

e. Fat Secret

g. Fit Bit

g. Other (please list):___________

16. Which wearable fitness tracking devices did you use to track your PA during your participation in this study?

a. FitBit

b. Jawbone

c. Fuel Band

d. General pedometer

e. Heath-monitoring watch

f. Garmin

g. Other (please list): ________________

h. I did not use any wearable fitness tracking device during the study

---

17. Often the media (newspaper, radio, etc.) would like to speak to our study participants about their experience participating in a weight loss study. Would you be willing to speak to the media in the future?

a. Yes

b. No

18. Our research group has many upcoming studies. Please indicate below if you would like to participate in future studies. Select all that apply below:

a. I'd like to participate in future studies

b. I don't want to participate but I would like to share information about future studies with friends or families

c. I would not like to be contacted about future studies

Appendix I – Aims 2 and 3 Comparison Group Weekly Questionnaire

1. What is your participant ID number: ____________________

2. What are your initials? _________

3. Have you joined another weight loss program: Yes or No; if yes, please list which one you have joined____________________________________.

4. How many podcasts did you listen to this week: ______________________

Thinking of the past 7 days:

5. On how many days during this past week did you log on to your tracking app?
0 1 2 3 4 5 6 7

6. On how many days did you record most (at least 75%) of the foods you ate this week?
0 1 2 3 4 5 6 7

7. On how many days did you record how much PA you did this week?

0 1 2 3 4 5 6 7

8. On how many days did you record your weight this week?

0 1 2 3 4 5 6 7

* On the week 6 survey, participants were asked to list their current weight (in pounds).

Appendix J – Aims 2 and 3 Experimental Group Weekly Questionnaire

1. What is your participant ID number: ____________________

2. What are your initials? _________

3. Have you joined another weight loss program: Yes or No;

4. If yes, please list which program you have joined____________________________________

5. How many podcasts did you listen to this week: ______________________

6. How many days during this past week did you log on to the Social POD app?

0 1 2 3 4 5 6 7

7. If applicable, how many times did you send a message to another user this week? ___________

8. If applicable, how many times did you receive a message from another user this week? _________

9. If you received a message from another user, did you then log on to the Social POD app to enter your weight, calorie intake, or exercise?

- Yes
- No
- Not sure/Can't remember

10. Did you encounter any problems while using the Social Pod app this week?

- Yes
- No

11. If you answered yes to the previous question, please describe in detail the problems you encountered:

____
____
____

12. Do you have any suggestions for improvements to the Social POD app? If so, can you please describe them in detail?

____

____

____

* On the week 6 survey, participants were asked to list their current weight in pounds.

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