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Are We Sure That Mobile Health Is Really Mobile? An examination of mobile device use during two remotely-delivered weight loss interventions

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Abstract

Background—The “m” in mHealth is often thought of as the ability to receive health information and monitor behaviors on the go. Little is known about how people actually use mobile vs. traditional access methods and if access method affects engagement and health outcomes.

Methods—This study examines the 3-month outcomes of two mobile weight loss interventions (Pounds Off Digitally (POD) and mobile POD (mPOD)) where participants were required to own a mobile device for study entry and received weight loss information via podcast. Only participants in both studies who were randomized to receive the same theory-based podcast (TBP) were used in this analysis. In POD, 41 participants were randomized to the TBP condition (37 to a control not included in this analyses). In mPOD, 49 participants were randomized to the TBP (n=49) and 47 to the TBP+mobile group (a self-monitoring app and Twitter app for social support). The goal of this study is to examine how participants accessed study components and to examine how type of device impacts engagement and weight loss.

Results—Examining data from both studies in aggregate, despite a mobile delivery method, 58% of participants reported using a non-mobile device to access the majority of the podcasts (desktop computers), 76% accessed the podcasts mostly at their home or work, and 62% were mainly non-mobile (e.g., sitting at work) when listening. Examining objective download data for mPOD, 49% of downloads (2889/5944) originated from non-mobile delivery methods vs. mobile platforms

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GTM is the first and corresponding author of the paper. GTM reviewed related papers, built the research hypotheses, conducted the studies, and wrote the manuscript.
DFT gave important comments on the research design, assisted with study implementation, and provided critical feedback on the manuscript.

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The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

(3055/5944). At 3 months, 55% of Twitter posts originated from the website (n=665 posts) vs. a mobile app (n=540; 45%). There was no difference in the number of podcasts participants reported listening to by device. There were more Twitter posts by mobile app users (51±11) than Twitter website users (23±6; $p<0.05$). There was a trend ($p=0.055$) in greater weight loss among mobile users for podcasts (−3.5±0.5%) as compared to non-mobile users (−2.5±0.5%). Weight loss was significantly greater in Twitter mobile app users (−5.6±0.9%) than website users (−2.2±0.5%, $p<0.01$).

Conclusion—Type of device used for podcast listening did not affect engagement but there was a trend toward greater weight loss among mobile users. Method of Twitter posting was associated with engagement and weight loss with mobile app users posting more to Twitter and losing more weight.

Keywords

telemedicine; weight loss; technology

Intro

Mobile Health (mHealth) is transforming the way traditional behavioral interventions are delivered. In the realm of delivering weight loss interventions, mobile technology has been used to deliver the content of behavioral weight loss interventions, to provide social support for weight loss, and to facilitate diet and physical activity (PA) self-monitoring [1–4]. During remotely-delivered weight loss interventions, the term “mobile” is often thought of as the ability for participants to take intervention information with them while performing other (active) tasks, such as walking, running, and monitoring behaviors (diet, exercise, etc.) on the go. The term implies a certain amount of freedom for participants and may be preferred over the traditional remote delivery methods (e.g. sitting at a desktop computer), which are more sedentary. The difference is often summarized by the network access method: mobile devices, such as mobile phones, tablets, or other portable devices, access the network “wirelessly” and can travel through time and space with the participant; “wired” is the traditional desktop access method and implies the participants are tethered to a particular device and are therefore more sedentary. Behavioral weight loss interventions which use mHealth technology rely on mobile means to allow participants to self-monitor diet and PA and to receive in-the-moment prompts and support. In addition, mobile devices may allow participants to access information at anytime, anywhere they are, which has the potential to increase compliance with provided dietary and PA advice. Despite these assumptions about the value of mobile delivery methods, little is known about how participants actually use mobile versus traditional access methods during weight loss interventions.

The purpose of this paper is to examine the use of mobile devices and traditional desktop computer access methods in two mobile weight loss interventions. The goal of this study is to examine how participants accessed study components and to examine the effects of type of device (mobile vs. non-mobile) with engagement and weight loss. This paper will address the following research questions:

1. ***Device, location, and activity:*** What devices were used to access study materials, where were participants when they accessed materials, and what activities were participants doing while listening to the podcasts?
2. ***Type of device and engagement:*** Does the type of device (mobile vs. non-mobile) used to access study materials (podcasts and Twitter posts) impact engagement with the study?

3. ***Type of device and weight loss:*** Does weight loss differ between those who use mobile devices to access study materials (podcasts and Twitter posts) vs. non-mobile devices.

We hypothesized that engagement and weight loss would be greater in mobile users for podcasts and Twitter due to the ability to access materials at any time and in any location, and, in the case of Twitter, be able to receive social support when needed.

Methods

This study examines the results of two remotely delivered weight loss interventions (n=174) administered between 2008–2011. The first study, the Pounds Off Digitally (POD) Study, was a 3-month randomized controlled weight loss trial among overweight adults, which compared an existing popular weight loss podcast on iTunes (control) to an enhanced, theory-based podcast (TBP) designed by the researchers [4]. The podcasts used in POD and mPOD have been described elsewhere [2, 4]. Briefly, podcasts were designed using constructs from Social Cognitive Theory [5] and were, on average, 15 minutes in length. Podcasts contained a section on nutrition and physical activity information (as recorded by a study weight counselor), an audio blog of a man or a woman trying to lose weight, a soap opera (which discussed weight loss topics), and a goal setting activity. The second study, the mobile Pounds Off Digitally (mPOD) study, was a 6-month randomized weight loss trial among overweight adults, which compared the TBP to the TBP plus self-monitoring of diet and PA using a mobile app and social support delivered via the social network Twitter (TBP +mobile) [2]. In POD, participants were required to own an MP3 player to enroll and were randomized to receive TBP (n=41) or a readily available weight loss podcast (control, n=37). In mPOD, participants were required to own an internet-capable mobile device (Android, iPhone, iPod Touch, or Blackberry) to enroll and were randomized to receive either the TBP (n=49) or TBP+mobile intervention (n=47). Because the control group in POD received a different podcast than the TBP groups and the TBP+mobile group, the POD control group was not included in these analyses. In both studies, participants were instructed to download two podcasts per week. In addition, those in the TBP+mobile group were instructed to download an app to self-monitor diet and PA and to join Twitter so they could follow other participants, post messages, and read messages from group members and study counselors (2 per day). Participants in both POD and mPOD attended an initial meeting after baseline data was completed in order to learn their random group assignment. Participants did not know each other prior to study enrollment. The online Twitter group for the TBP+mobile group included all members of the TBP+mobile group. Participants in the TBP+mobile group were provided with a list of the Twitter user names for all TBP+mobile participants and were instructed to follow all the participants. Participants were free to create anonymous user names and use avatars which did not identify them. Participants were provided with an overview of how to download the Twitter app and post to Twitter at their orientation session. Participants were free to post as often as they liked and topics were not restricted. Study counselors posted messages (two/day), which reinforced the topics presented within the podcasts.

To standardize across groups for analysis, 3-month outcomes (weight loss, use of study materials, technology access methods) were used for both studies. Participants in both the POD and mPOD studies reported how they accessed the podcasts on a 3-month questionnaire by indicating which device was used most often to listen to the podcasts (MP3 player, iPhone, Android phone, BlackBerry, iPOD Touch, Desktop computer, etc.). Participants were classified by which method they used to access podcasts as mobile (MP3 player, smartphone, etc.) or non-mobile (desktop computer). In addition to self-report methods, in mPOD, objective podcast download data from the podcast hosting site was used

to explore type of device downloading the data and to verify the self-report data. Objective download data was dichotomized as either mobile (e.g., Android Download Manager) or non-mobile (e.g., QuickTime). Participants were also asked on the 3-month questionnaire where they were most often when they listened to the podcasts (e.g., home, work, gym, etc.) and what they were doing while listening to the podcasts (e.g., sitting at a desk, eating, etc.). In addition, in mPOD, Twitter posts were coded for which type of method was primarily used for posting (based on the method most frequently used by each participant as objectively recorded on the Twitter site): mobile (a mobile Twitter app) or non-mobile (Twitter's website). Weight was assessed in both studies using a calibrated digital scale accurate to 0.1 kg at 3 months. Baseline weight values were carried forward for participants missing a 3-month weight assessment.

Statistical analysis

For demographic characteristics, chi-square test of independence was used to examine differences in categorical variables and independent t tests were used to examine differences in continuous variables. To examine the relationship between device used for podcast download (mobile or non-mobile) with number of podcasts listened to and percent weight loss, General Linear Models (GLM) were used. GLM was also used to examine differences in the number of posts to Twitter and % weight loss by posting method, adjusting for age. All analyses were conducted using SPSS for Windows software, version 20.0.0, with a *p*-value of 0.05 used to indicate significant differences.

Results

Baseline demographics of the groups organized by device used for podcast download and Twitter posting are presented in Table 1. Primary results for POD [4] and mPOD [2] are reported elsewhere. Briefly, in POD, participants in the TBP group lost significantly more weight than the control podcast group (−2.9±3.5 kg TBP vs −0.3±2.1 kg control; $p<0.001$ between groups). In mPOD, there was no significant difference in percent weight loss at 6 months between TBP (−2.7%±5.6%) or TBP+mobile (−2.7%±5.1%, p=0.98). Twitter was used as a way to allow participants to communicate with one another and receive messages from study counselors using a low burden approach (short messages ≤140 characters or less). As has been previously reported, posts to Twitter mainly provided participants with informational social support (primarily in the form of status updates) and posting to Twitter was associated with greater weight loss [6]. For both POD studies combined (excluding POD control group), 125 participants (out of 137) completed the primary 3-month outcome of body weight assessment and 123 completed the 3-month questionnaires. In the TBP +mobile group, 3 participants used a dashboard tool (e.g., Tweetdeck, Hootsuite, etc.) for posting and it could not be determined if this was a mobile or desktop application so they were excluded from analysis. In addition, only participants who posted at least once to Twitter are included in analyses resulting in a sample of 41 out of 47 participants.

Table 1 provides details on device usage and demographics by group. In POD, 53% of participants reported using a desktop computer to listen to podcast, 40% reported using an iPod, and 7% reported using another Mp3 player device. In mPOD, 57% listened to the podcasts on a desktop computer, 20% used an iPhone, 15% used an iPod, and 8% used another mobile smartphone (e.g., Android, BlackBerry). In both POD studies combined, there were no significant differences in age, ethnicity, gender, or baseline BMI among participants who used mobile or non-mobile methods to access the podcasts. There were no differences among TBP+mobile participants in ethnicity, gender, or baseline BMI by mobile and non-mobile Twitter posting methods. However, there was a trend towards participants using the Twitter website (46±9 years) being older than participants who used the Twitter

app to post (40±1 years, p=0.068). Therefore, models exploring differences by Twitter posting method are age adjusted. There was no significant differences in the number of participants who had reported downloading a podcast prior to study enrollment and no difference between mobile and non-mobile Twitter users and number of users reporting to be a member of Twitter at baseline.

Devices, locations, and activities associated with study material access

Examining data from the two POD studies in aggregate, despite the requirement to own mobile technology to participate in the intervention, half of participants (n=71, 58%) used a non-mobile device to access the podcasts (mainly desktop computers), with 24% (n=29) using an MP3 player, and 19% (n=23) using a smartphone. The majority (76%) of participants accessed the podcasts at their home (n=67) or work (n=25) (which may not necessitate use of a mobile device for access). The remaining participants reported primarily accessing the podcasts in their car (n=8, 7%), while exercising (n=10, 8%), or while traveling or commuting (n=11, 9%) (2 did not report a location). The majority of participants (62%) reported being sedentary and non-mobile while listening to the podcasts such as sitting at a desk (n=43, 36%), sitting at home (n=31, 26%), or eating (n=3, 3%). Examining objective download data from the podcast hosting site for mPOD, 49% of downloads (2889/5944) originated from non-mobile delivery methods (e.g., QuickTime) vs. mobile platforms (3055/5944 downloads) (e.g., Android Download Manager). There were significantly more podcast downloads in the TBP+mobile group (n=3317) than the TBP-only group (n=2627; p<0.001) but slightly more of the downloads in the TBP group were from mobile sources (54%) than in the TBP+mobile group (49%), demonstrating that incorporating more mobile components (apps, Twitter, etc.) did not necessarily draw participants to use their mobile device more often. Examining objective Twitter data for method of posting, 55% (n=665) of the messages posted in the first 3 months originated from use of the Twitter website (non-mobile) and 45% (n=540) of the posts came from mobile apps.

Type of device used and engagement

Engagement in both POD studies was assessed by number of reported podcasts listened to over 3 months (mean±SD). There was no difference (p=0.96) in the number of podcasts (out of 24) participants reported listening to between mobile (17.2±7.5) and non-mobile users (17.2±7.6). Among TBP+mobile group members in the mPOD study, there was a significant difference in the number of posts (mean±SE) to Twitter at 3 months by Twitter posting method (as categorized by objective Twitter posting data). Users who posted to Twitter using a mobile app posted significantly more messages (51±11) than those using the Twitter website (23±6; p<0.05).

Type of device used and weight loss

The primary outcome in both examined studies as part of this analysis was weight loss (mean±SE). Examining both POD studies in aggregate, there was a trend toward significantly greater weight loss among mobile users for podcast downloads (−3.5±0.5%) as compared to non-mobile users (−2.5±0.5%, F=3.8, p=0.055). Examining just the TBP +mobile group (the only group to use Twitter in the studies), type of device used for Twitter posting was significantly associated with percent weight loss (mean±SE) at 3 months. Those using a mobile app to post to Twitter lost significantly more weight (−5.6±0.9%) than website users (−2.2±0.5%, p<0.01).

Discussion

There has been an increase in the use of mobile technology for health [7], yet little is known how people use technology to access and use health information. In addition, as mobile technology becomes more advanced (moving from a portable music player to a portable computer), health behavior researchers are able to design and deliver interventions that can be scalable and can provide multiple delivery channels. This paper examined how participants in two mobile weight loss studies accessed podcasts and Twitter and explored how type of device (mobile vs. non-mobile) impacts engagement and weight loss. The results show that despite requiring mobile device ownership for study entry, more than half of study participants still accessed podcasts and Twitter using non-mobile methods. And while engagement didn't differ by device for podcast downloads, mobile methods may have led to more engagement with Twitter. Mobile Twitter posting methods were also associated with greater weight loss, with a trend toward greater weight loss among mobile podcast users.

Although participants enrolled in both POD studies had a mobile device to access the podcasts, less than half chose to use this as their primary device for podcast listening. There could be several reasons for this. Since home and work were the two most common places to listen to the podcasts, participants may have found it easier to plug headphones into their computer and listen while multitasking at their desks. In addition, while podcasts were posted two times per week using Real Simple Syndication (RSS) feeds, allowing participants to subscribe to the podcasts, a direct link was also e-mailed out as a prompt to participants when a new podcast was posted. This prompt may have led to participants clicking the link when they received the e-mail, while at their desktop computer, instead of waiting to sync their mobile device for a podcast download. If participants were only able to access the podcasts via a mobile app on their device (as is common with some podcasts now), then this could have changed how participants would have accessed the podcasts. It is possible that use of mobile devices would differ if the study was conducted now or among different populations. In addition, performance of the device, connectivity speed, and data plans were not assessed—all of which could impact access to the intervention components. Other studies have also shown that even when participants access content with their mobile devices, they are sitting indoors [8]. In both POD studies, participants were mostly white women in their mid-30s to early-40s. African Americans and Hispanics are more likely to own mobile phones [9] and use their phones to find health information [7]. Use of mobile phones among all groups is growing [9]. We are currently conducting a remotely-delivered weight loss intervention among overweight women with Polycystic Ovary Syndrome (n=18, mean age 28.5, 39% African American). While participants were not required to own a mobile device to enroll in the study, the majority of participants (n=10) reported using a mobile device "often" or "very often" to access study related materials, search for recipes, and search for diet-related information during the study. In addition, very few participants in both POD studies were actually mobile (walking, driving, etc.) while listening to the podcasts. While the podcasts encouraged regular walking and other physical activity, few participants chose to listen to the podcasts while being physically active. Future studies using podcasts for weight loss may want to incorporate exercise specific information that encourages listeners to be physically active during the podcasts.

Engagement with the technology used to deliver health-related interventions is an important area of research since receiving the health-related intervention relies on an individual to use the technology [10]. In remotely delivered weight loss interventions, engagement with the technology used can be predictive of successful weight loss [11, 12]. Number of podcasts downloaded did not differ by device used; however, there was a significant difference in the number of posts to Twitter by posting method. Mobile app users were more active on

Twitter than non-mobile users. Using a mobile method to post to Twitter may have allowed for more frequent access to content and the ability to post messages in-the-moment. In addition, accessing Twitter via a mobile device may have provided participants with social support in times and locations where they would need it (at a restaurant, getting into their car, deciding if they want to go to the gym, etc.). Social networking sites hold promise as a way to provide support for health behaviors [13].

Our previous research found that posting to Twitter within the TBP+mobile group was associated with greater weight loss [6]. In the present analysis, Twitter mobile app users lost significantly more weight than those using a website. It is possible that more motivated users who were adherent to study recommendations chose to use mobile methods to post to Twitter or using mobile Twitter-posting methods allowed for more frequent contact and message delivery, leading to greater weight loss. In addition, there was a trend towards greater weight loss among participants in both POD studies who used mobile methods to access the podcasts as compared to those who used traditional desktop access methods. This result could possibly be due to differences in how much of the podcast information was processed by the participant because of differences in distractions while the podcasts were accessed, when podcasts were accessed, or listening method used. For example, it has been observed that there are frequent interruptions at the workplace [14], so it is possible that participants who used mobile devices to access podcasts (away from work) were less distracted than desktop users at work, and therefore received more of the content of the podcasts. Mobile users may also have had the ability to listen to podcasts when they were most ready to receive the information versus only when they were near their computer. Lastly, there are differences in psychophysiological responses between listening to audio using headphones (as would occur most of the time with mobile methods) and using speakers (which may occur with desktop methods), with greater attention to content occurring during listening with headphones [15].

This study is one of the first to examine device type for two different mobile information delivery methods (podcasts and an online social networking site) as it relates to engagement and weight loss. The results point to advantages of using mobile delivery methods, particularly around use of social networking sites. Receiving real-time social support may help people stay engaged and feel supported and therefore, mobile methods should be investigated for social support provision during remotely-delivered weight loss interventions. There are some limitations to this study. The study was conducted in mostly white women in a narrow age range, which makes it difficult to generalize the findings to other populations. In addition, since 2011, when mPOD was conducted, there have been even greater advances in and adoption of mobile technology, which may lead to greater utilization in future studies. Also, the present analysis examined which methods participants chose (mobile vs. non-mobile) and does not include groups randomized to these methods. Future studies could examine these weight and engagement outcomes using a randomized design. In addition, subjective report was primarily used to assess device used for podcast download. There are several advantages to the study as well. With similar measures and delivery components, both POD and mPOD could be combined to have a larger sample size for analysis. In addition, both objective and subjective measures of technology use were utilized as part of the study. Participants also entered the study with their own mobile device, meaning they did not have to learn a new technology and would have been more comfortable with their own device than one provided for them and they did not have to use an outdated device if they wished to upgrade their device during the study, or carry two devices—one specifically for study purposes.

In conclusion, it may be useful to provide participants with multiple methods of receiving behavioral intervention material but encouraging mobile methods for receiving social and

behavior change support may be important in order to encourage improvements in health-related behaviors. Future studies should examine what components of remotely-delivered weight loss interventions encourage engagement and produce long-lasting health behavior changes.

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Research Highlights

- People may choose non-mobile methods of receiving health information if they have a choice of methods.
- Mobile methods of receiving social support may increase engagement.
- Accessing social networks using mobile devices may assist with weight loss.

Summary Table

What is known:

- Adoption of mobile technology around health behavior interventions is growing.
- Engagement in weight loss interventions is a predictor of successful weight loss.

What the study added to our knowledge:

- People may choose non-mobile methods of receiving health information if they have a choice of methods.
- Mobile methods of receiving social support may be important for engagement and weight loss.

Table 1

Demographic characteristics by study, device used for podcast downloads, and method used to post to Twitter

	Pod and mPOD primary device for podcasts (n=123)		**mPOD (TBP+mobile group) device used to post to Twitter (n=41)**	
	Mobile device (n=52)	***Desktop computer (n=71)***	***Mobile app (n=11)***	***Twitter website (n=30)***
Gender				
Female	37 (71%)	53 (75%)	9 (82%)	25 (75%)
Male	15 (29%)	18 (25%)	2 (18%)	5 (25%)
Age (years± SD)	41±11	44±11	40±11	46±9[a]
Ethnicity				
Black	4 (8%)	13 (18%)	1 (9%)	7 (23%)
White	45 (86%)	58 (82%)	9 (82%)	22 (73%)
Other	3 (6%)	0	1 (9%)	1 (4%)
Hispanic				
Yes	2 (4%)	0	11 (100%)	30 (100%)
No	50 (100%)	71 (100%)	0	0
Body Mass Index (kg/m^2)	32.8±4.4	31.8±3.9	33.3±5.3	32.9±4.4
Downloaded a podcast prior to study?				
Yes	41 (79%)	47 (66%)		
No	11 (21%)	24 (44%)		
Member of Twitter prior to study?				
Yes			5 (45%)	8 (27%)
No			6 (55%)	22 (73%)

POD: Pounds Off Digitally

mPOD: mobile Pounds Off Digitally

TBP+mobile: Theory-based podcast plus mobile intervention (including Twitter use)

[a]Difference between app and website is p=0.068.