

Weight loss—there is an app for that! But does it adhere to evidence-informed practices?

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Abstract

Little is known about how much smartphone apps for weight control adhere to evidence-informed practices. The aim of this study was to review and summarize the content of available weight control apps. Information on content, user rating, and price was extracted from iTunes on September 25, 2009. Apps ($n=204$) were coded for adherence to 13 evidence-informed practices for weight control. Latent class analysis was used to identify subgroups of apps based on endorsement practices. Only a small percentage of apps had five or more of the 13 practices (15%). Latent class analysis revealed three main types of apps: diet, physical activity, and weight journals (19%); dietary advice and journals (34%); and weight trackers (46%). User ratings were not associated with apps from these three classes. Many apps have insufficient evidence-informed content. Research is needed that seeks to develop, improve, and evaluate these apps.

Keywords

mHealth, Weight loss, Smartphones, Apps

INTRODUCTION

The prevalence of overweight or obesity in the USA is of high public health concern [1, 2]. Maintaining a healthy weight can reduce one's risk for a number of chronic diseases [3]. First lines of treatment for many individuals attempting to lose weight are self-help programs. These can include a number of different methods, such as books, “how-to” manuals, and commercial programs [4, 5]. Advances in communication technologies have pushed these self-help and commercial programs to Internet platforms and more recently to mobile smartphones [6, 7].

As of 2010, there were an estimated 293 million mobile phone subscribers in the USA [8]. About one third (31%) of these subscribers are smartphone users, and this group of smartphone users is fairly diverse with respect to racial/ethnic minority status [9]. Blackberry RIM, Apple, and Google each have about 29% of the US smartphone market share [9]. There are numerous health-related applications (“apps”) available for smartphones that are marketed for helping individuals manage or improve

Implications

Practice: Although popular among the lay public, many smartphone apps may lack comprehensive evidence-informed recommendations or practices for healthy weight control, so practitioners need to discuss the utility of these apps with patients if patients are using them as a supplement to treatment.

Policy: There are no industry standards so app developers will need to consider incorporating evidence-informed content.

Research: Continued research is needed that sheds light on the accuracy of smartphone apps for health behavior change in the public domain, and research is also needed that seeks to develop, improve, and evaluate these apps.

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their health, such as for diet, physical activity, or weight loss.

Smartphone apps may be promising for helping people improve their health [10]. However, research on apps for these and other health promotion purposes has not kept pace with technological innovations, and their efficacy is yet to be determined [11]. While little is known about the efficacy of smartphone apps, a systematic review of the literature on Internet-based approaches concluded that Internet-based approaches are efficacious for improving behavioral outcomes, including in the arena of weight loss [12, 13]. Many of the reasons that make Internet approaches promising may apply to smartphone apps. The treatment effect sizes of Internet-based approaches are not large, but their potential to reach a large audience could result in a meaningful public health impact [14]. Some of the reasons that Internet platforms are efficacious may be due to ability to provide a tailored experience along with the ease of self-monitoring [12, 15, 16]. Mobile apps have the additional appeal of being portable and available to a person regard-

less of their location or setting [17]. Tailored feedback and self-monitoring are both relevant in behavior change interventions. Apps have the potential to further increase the ability to receive tailored feedback and self-monitor because they run on mobile devices allowing for easy access and use. Unfortunately, little is known about the types of apps that are available, the features they contain, and the degree to which apps incorporate evidence-informed practices for healthy weight loss and weight management.

Certain strategies and practices for weight loss have received empirical support. For instance, moderate caloric restriction with reduction in fat intake and increases in fruit and vegetable intake are generally accepted and effective strategies [18, 19]. Controlling portion size and self-monitoring of diet and weight are also established weight management practices [20, 21]. Maintaining regular physical activity especially subsequent to weight loss is also recommended because studies have shown physical activity to be associated with weight loss success [22]. Finally, social influences (e.g., social networks, social norms, and social support) are also thought to be relevant and influential in weight loss programs [23, 24]. Based on the evidence, a number of leading governmental agencies have provided recommendations for individuals who want to manage their weight.

Being able to compare apps based on concordance with evidence-informed practices would be helpful for consumers and practitioners alike. A review of the available apps would also provide researchers wishing to develop apps with insights into the types of apps that potential participants might like and find useful as well as how future apps could be improved and expanded. The overall purpose of this study was to review and summarize the content of the first generation of iPhone apps for weight loss and management available as of September 25, 2009. This was done by first determining the degree to which an app adhered to evidence-informed practices for weight loss and weight management. Additionally, using a latent class analysis, this study aimed to evaluate the different types of apps that were available on the market. The user ratings and price of these apps were also described.

METHODS

Selecting apps for review

A listing of apps available for download at www.apple.com/itunes on September 25, 2009 was collected using the Power Search function of iTunes version 8.1. The phrases “weight loss” and “diet” were used as search queries. Out of more than 1,400 apps in the “Healthcare & Fitness” category, 204 directly related to weight loss and weight management (see [online appendix](#)). Apps that included a basic and deluxe version were counted as separate

apps, as they could differ in the types of weight loss or weight management advice included. The iTunes description page for each app was used as the basis of the review. This consisted of an overall description of what the app does, a list of features the app offers, user ratings, customer reviews, and one to four screenshots of what the app looks like when downloaded.

Assessing evidence-informed practices

Apps were reviewed and coded for their level of adherence to 13 evidence-informed practices common to all of the following governmental agencies: the Centers for Disease Control and Prevention [25], National Institutes of Health [26], the Food and Drug Administration [27], and the US Department of Agriculture [28]. These practices and the indicators of adherence were as follows: (1) assess one’s weight (scored on whether the app provided a means of calculating one’s body mass index with an interpretation of what that means), (2) eat a diet rich in fruits and vegetables (scored on whether the app recommended a certain number of daily servings fruits and vegetables or allowed users to track their number of servings each day), (3) perform regular physical activity (scored on whether the app recommended a certain amount of physical activity each day per week), (4) drink water instead of juice or soda (scored on whether the app recommended a certain number of daily serving of water or allowed users to track their daily servings of water), (5) keep a food diary (scored on whether the app allowed users to track the daily food consumption), (6) maintain calorie balance of in vs. out (scored on whether the app allowed for users to calculate the number of calorie needed in order to meet desired weight loss/maintenance goals given one’s activity level), (7) weight loss of 1 to 2 lb a week (scored on whether the app recommended weight loss goals of 1 to 2 lb/week), (8) portion control (scored on whether the app described or illustrated portions sizes or let users look up nutritional information according to portion size), (9) read nutrition labels (scored on whether the app recommended reading labels, described how to properly read labels, or let users look up nutritional information for food items), (10) track your weight (scored on whether the app provided a means to track weight over time), (11) keep a physical activity journal (scored on whether an app provided a means to track daily physical activity), (12) plan meals (scored on whether the app recommended users plan their meals, had a tool for menu planning, or a way to search recipes), and (13) seek social support (scored on whether the app allowed users access to social support components like message boards, chat rooms, email an expert, or a networking component like Twitter).

Using the iTunes description page, all 204 apps were independently coded by the first author and a

researcher assistant trained in the coding scheme. An index was created based on whether or not the app adhered to any of the 13 evidence-informed practices. The two coders reached consensus for 94% of the apps in the sample. Apps that were rated differently were discussed, and a final decision was made by the first author. This method of assessing content (i.e., developing an a priori index based on evidence-informed practices and then determining adherence to such practices) has been used by others conducting similar reviews of apps and Internet websites focused on tobacco cessation [10, 29].

User ratings and price

Average user ratings on the iTunes description page were collected for each of the 204 apps. Apps that did not have a rating were coded as “not rated.” Among those rated, ratings were in increments of 0.5 and ranged from 1 (lowest) to 5 (highest) stars, reflecting the extent to which users liked the app. The price of each app was coded into one of three categories: free, \$0.99–4.99, or \$5.00–19.99. None of the apps were more than \$19.99.

Top 20 paid and free apps

Within specific categories (e.g., Healthcare & Fitness, etc.), iTunes posts the top 20 paid and top 20 free apps downloaded on a specific day. It was noted whether any of the 204 apps included in the sample were in the top downloaded apps. Being in the top 20 is an indication of an app’s popularity among iPhone app users.

Features of the apps

The general features were summarized across the 204 apps. This included noting if the app contained (1) interactive tools, like food and/or exercise diaries, recipes, and weight graphs or charts; (2) food nutritional databases where users could look up calories, fat, and fiber on a wide variety of foods; (3) educational materials that would provide advice on weight management or weight loss; (4) whether or not the app was designed to be able to use in conjunction with a Internet website; and (5) if the app had a social support/networking component (i.e., allowed for interactions with others, provided a means to garner support from an expert, provided a messaging board, or had way to link with a social networking site like Twitter).

Data analysis

Descriptive statistics were used to summarize the percentage of the each of the 13 evidence-informed practices that were available across the 204 apps and to identify the percentage of apps with 0 to 13 practices. Latent class analysis (LCA) was performed to identify if there were certain types of apps based on endorsement patterns of the 13 evidence-informed practices. LCA, a finite mixture modeling

approach, is a useful method for identifying whether there is particular constellation of characteristics that are best represented by distinct classes or subgroups [30, 31]. The number of classes is considered iteratively until the best-fitting model is identified using substantive criteria and goodness-of-fit statistics (Lo–Mendel–Rubin likelihood ratio test (LMR-LRT), Bayesian information criteria (BIC), sample-size adjusted Bayesian information criteria (SSA-BIC), Akaike’s information criteria (AIC), and entropy) [30, 31]. LCA models were specified using Mplus version 6.1 [32]. Analysis of variance was used to compare the mean user ratings for apps with the types of apps identified from the LCA. To evaluate if pricing was related to the different types of apps, Fishers exact test was used to assess the relationship between types of apps and pricing category.

RESULTS

The 204 apps were first reviewed to determine if they generally contained information and content that would be considered standard or conventional weight loss/management information or recommendations. Nearly all were in this category (89%). However, some contained unconventional strategies or information. These strategies included the use of colors and sounds to help facilitate appetite restraint, placing the phone on one’s stomach while the vibrate function was active in order to break up fat cells, “detox” diets (e.g., eating apples frequently or drinking only lemonade), or provided positive affirmations to encourage staying on one’s diet.

Of the 204 apps, 6% ($n=12$) did not have any of the 13 practices, and none of the apps had all 13. The percentages for the remaining were as follows: 1=25% ($n=50$), 2=30% ($n=62$), 3=19% ($n=38$), 4=6% ($n=12$), 5=4% ($n=9$), 6=2% ($n=4$), 7=3% ($n=7$), 8=0.9% ($n=2$), 9=1% ($n=3$), 10=0.9% ($n=2$), 11=0.9% ($n=2$), and 12=0.5% ($n=1$). Table 1 reviews the presence of the 13 evidence-informed practices across the 204 apps. Forty-three percent of the apps recommended or provided a tool for keeping a food diary (43%). Many of the apps also recommended or provided a tool to calculate one’s body mass index (BMI) (36%) and recommended or provided a tool to track one’s weight (34%). Less than 10% of the apps offered advice on meal planning, offered the advice to drink water instead of soda or juice, or provided the recommendation to aim for a 1- to 2-lb loss per week.

Two apps in the sample were listed in the Apple App Store’s list of top 20 paid apps: (1) Tap & Track–Calorie, Weight, and Exercise Tracker and (2) Calorie Tracker by LIVESTRONG.COM. Tap & Track–Calorie, Weight, and Exercise Tracker had eight of the evidence-informed practices and a user rating of 3.5, and Calorie Tracker had nine of the evidence-informed practices also with a user rating of 3.5. One app was listed among the top 20 free (weight watchers)

Table 1 | Percent of each evidence-informed practice among the 204 apps reviewed

Practices	Percent
Keep a food diary	43
Assessing your weight	36
Maintain calorie balance	34
Keep a physical activity journal	27
Portion control	25
Read nutrition facts labels	22
Regular physical activity	21
Eating a Diet Rich in Fruits and Vegetable	12
Meal planning	9
Drink water instead of soda or juice	7
Loss of 1 to 2 lb/week	6
Social support	3

and had seven of the evidence-informed practices and an average user rating of 2.5.

Summary of features of apps

With respect to the types of features that the apps contained, interactive tools were present on 70% ($n=144$) of the apps, food nutritional databases were present on 33% ($n=67$) of the apps, and educational materials were present on 20% ($n=40$) of the apps. Fifteen percent of the apps ($n=30$) were designed to be used in conjunction with an Internet website. Only 3% of apps ($n=7$) had components that allowed for some type of social networking or support. One app (MyNetDiary-Online Calorie Calculator) had all four of the social support/networking features (allowed for interaction with others, provided a means to connect with an expert, had a messaging board, and connected to social media). Most of these others (five of six) only allowed for interaction with others by email, and the remaining app provided a means to connect with an expert as its social support/networking feature.

Latent class enumeration and profiles

The goodness-of-fit indices for the four latent class models are presented in Table 2. These indices indicate a three-class solution as the best-fitting model, as the AIC, BIC, and SSABIC were all lower compared to earlier models. Only small decreases were observed in these indices with a four-class model, and the LMR-LRT indicated that the four-class model is not a better fit than the three-class model (p value=0.25). The average conditional probabilities indicated that the three classes were all well-defined: 0.955 for class 1, 0.944 for class 2, and 0.929 for class 3. Figure 1 depicts the endorsement probabilities across the 13 evidence-informed practices. These indicate that the apps differed in their coverage of the 13 practices. The first class (labels diet, physical activity, and weight journals) comprised of 19% ($n=40$) of the apps and was characterized by a high probability of the following 13 practices: advocated maintaining a calorie balance (1.0), allowed for keeping a physical activity journal

(0.94), allowed for keeping a food diary (0.93), advocated regular physical activity (0.67), allowed for tracking weight (0.65), and had a BMI calculator for assessing weight (0.46). The remaining criteria had endorsement probabilities <0.37 . The second class (labels dietary advice and journals) comprised of 34% ($n=70$) of the apps and was characterized by a high probability of advocating portion control (0.50), allowed for keeping a food diary (0.49), and reading nutritional labels (0.48). The remaining criteria had endorsement probabilities below 0.2. The third class (labeled weight assessment and tracking) comprised of 46% ($n=94$) of the apps and was characterized by a high probability of having a BMI calculator for assessing weight (0.61) and allowed for tracking weight (0.42). The remaining 11 criteria had probabilities below 0.16.

User ratings and price

Of the total 204 apps, 33% ($n=67$) were not rated. Among those that were rated, the average rating was 2.5. Average user ratings were similar for the different three different types of apps identified from the LCA (physical activity and weight journals mean=2.54, SD=0.80; dietary advice and journals mean=2.44, SD=0.79; weight assessment and tracking mean=2.57, SD=0.78). With respect to cost, 23% were free, 69% cost between \$0.99 and \$4.99, and 8% cost between \$5.00 and \$19.99. App type was not related to price (Fisher's exact p value=0.13).

DISCUSSION

In this study, we reviewed the content of 204 apps that were available through iTunes in September 2009 to determine the extent to which these apps would be consistent with 13 evidence-informed practices for weight control. Our main finding was that a majority of these apps adhered to one to two evidence-informed practices. Our findings also suggest that of these first generation apps, there were three main types. Apps used for assessing weight (BMI) and tracking weight comprised a majority

Table 2 | Fit indices for a one-class model through to a four-class model

Model	Fit statistics				
	AIC	BIC	SSABIC	Entropy	LMR-LRT
1 class	2,479.297	2,522.432	2,481.245	N/A	N/A
2 class	2,274.08	2,363.669	2,278.125	0.936	0.0002
3 class	2,161.574	2,297.617	2,167.716	0.87	<0.0001
4 class	2,108.591	2,291.088	2,116.832	0.886	0.2504

Best-fitting model in bold type

AIC Akaike's information criteria, BIC Bayesian information criteria, SSABIC sample-size adjusted Bayesian information criteria, LRT-LMR p value for the Lo-Mendel-Rubin likelihood ration test

followed by dietary journals or apps that offered dietary advice and in the minority were apps that would be considered the most comprehensive of the 13 best practices. These more comprehensive apps allowed for keeping journals for weight, diet, and physical activity.

It was notable from the LCA that many of these first generation apps had sparse or limited coverage of the 13 evidence-informed practices. For instance, apps with weight-related tools, like BMI calculators, or methods for tracking weight were less likely to also include other helpful strategies with respect to weight, such as advocating a reasonable weekly weight loss goal of 1 to 2 lb. Also, another large proportion of these first generation apps were tools for tracking diet. These apps were less likely to also include information about physical activity which could be useful to more accurately estimate calorie balance. Notably, there were some first generation apps with notable strengths, following many of the evidence-informed practices for weight

loss. These apps that adhered to multiple guidelines had useful tools, such as food and exercise diaries, recipes that could be easily accessed, personalized weight graphs and charts, nutritional databases for looking up calorie content, and the ability for the user to synchronize the app with an Internet website. However, apps with numerous features like this were not common. Subsequent studies are needed to determine if second-generation apps are able to expand the coverage of evidence-informed practices.

Some examples of apps that were more innovative included Food Scanner, SparkPeople, and Fast Food Calorie Hunter. Food Scanner allows users to scan barcodes with their phone's camera in order to view and upload the nutritional information directly into their personal food diary. SparkRecipes, a website that contains hundreds of healthy recipes uploaded from online users is linked with the SparkPeople app so that users can easily access the recipes remotely. For people who fast food frequently, Fast Food Calorie Hunter provides calories and nutri-

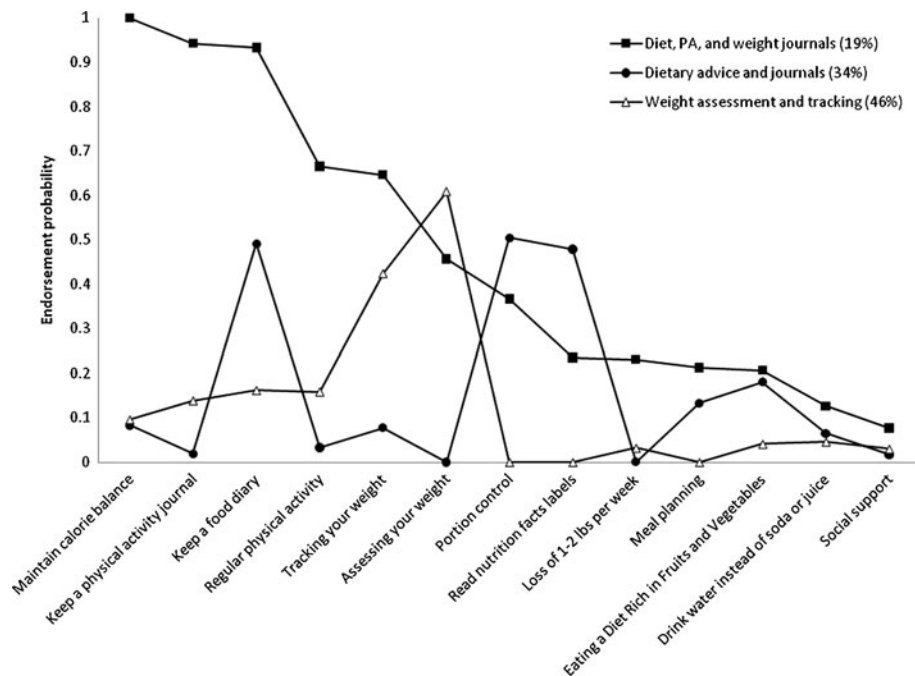


Fig 1 | Latent class profile plot of the probability of having each of the 13 evidence-informed practices across the three latent classes

tional content for many common fast food items. Education about healthy fast food options has been used as a key component of Internet-based weight loss programs [33–35]. Fast Food Calorie Hunter provides this information and is also linked with a location tracker to view fast food venues that are closest in proximity to one's location. These apps are innovative in that they appear to reduce the burden of self-monitoring and planning. Recent research has shown that electronic self-monitoring is more effective at changing weight outcomes than the more cumbersome paper diaries [36]. It is conceivable that apps which allow for self-monitoring and planning will improve weight loss adherence and ultimately be more effective at inducing weight change than those without such features. Research on the efficacy for these types of apps is needed.

A notable limitation of these first generation apps was that very few incorporated methods for maximizing social support. Ongoing social support from family and friends, as well as other sources (e.g., professional help), may help to sustain weight loss efforts [24] and group-based treatment approaches improves efficacy over individual treatment approaches [37]. For technology interventions, this may be especially crucial, since users of the intervention are likely to be geographically dispersed and thus lack access to others who are going through the same treatment. Further, a social support component to a technology-based intervention may also be useful in that the online support community may foster engagement in the intervention—users may return to the technology if there is the benefit of a supportive online community [38, 39]. In our sample, only 7 of the 204 apps provided any means to support or interact with others. Two of these apps additionally had the ability to link users with an online community (e.g., message boards or Twitter). The inclusion of a social community in these apps will likely change rapidly, as social networking has become a key feature of the online experience. In fact, some of the apps we reviewed which did not have the capacity to link with others at the time now do (e.g., Weight Watchers recently updated their app to include access to their new online beta community).

To date, we are not aware of any efficacy studies of commercially available smartphone apps. However, several studies have demonstrated that text messaging for weight loss on regular mobile phones (feature phones) is feasible and effective. For example, one recent study found that a research-designed mobile phone intervention providing automated and interactive text messages with personalized feedback was more effective at inducing short-term weight loss than print-based self-help materials [40]. The growing evidence for the efficacy of text messaging implies that until we have evidence on what is effective with smartphone apps, smartphone apps should be designed to include proactive and

interactive text messages as a feature of the app. It is noteworthy that none of the apps examined for this study used proactive alerts or text messages to promote behavior change.

This study highlights the many shortcomings of the first generation apps. However, as in any study, the results should be considered with respect to the limitations. First, we based our review on the description that the app developer provided on the iPhone store. We did not download each of the 204 apps and confirm that this information accurately described the apps features and tools. Thus, it is possible that an app might have had more or fewer of the recommended evidence-informed practices than included in the description. While Apple executes a rigorous review process that tests all submitted apps for software bugs, instability on the iPhone platform, and use of unauthorized protocols, they do not review apps for content validity. Another limitation is that our reliance on user ratings as an estimate of likeability may reflect the biases of users who choose to rate an app and also we did not account for the number of ratings. Despite limitations, this measure has been used in previous studies [41]. Collecting additional information about the number of raters or the number of downloads may have improved our precision, and such similar future studies would be advised to collect this type of information. Although not necessarily, a limitation of this study in particular, but of these types of studies in general, is that the technological advances often outpace research efforts. In this study, we sampled and reviewed the available apps at a certain point in time. Many of these apps could have been improved or possibly discontinued since our data collection time point. A second cross-sectional study could help confirm some of our findings here. Finally, our study examines app content in relation to evidence-informed practices as a first step within this field of study. What is clearly needed as research progresses in this area is information about the effectiveness of these apps in assisting in successful weight loss and weight management.

The strength of this study is that it is the first of its kind to evaluate the degree to which the content of commercially available weight control apps adhere to evidence-informed practices. While similar studies exist for diabetes management and smoking cessation, no known studies have looked at smartphone apps for weight control [10]. The study of smoking cessation apps also found that they contain serious omissions in the adherence to established guidelines. Such findings highlight the vast chasm between the wide availability of health apps and their adherence to evidence-based practices.

As mobile computing technology improves and availability of smartphones becomes more ubiquitous, specialized apps for helping individuals manage their daily health and adhere to treatment

recommendations are becoming more popular. Until research catches up with the pace of technological development, users of such apps may be well advised to seek additional sources of self-help, preferably those that have received professional input and evaluation.

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