Dietary Self-Monitoring, But Not Dietary Quality, Improves With Use of Smartphone App Technology in an 8-Week Weight Loss Trial
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ABSTRACT
Objective: Dietary self-monitoring is linked to improved weight loss success. Mobile technologies, such as smartphone applications (apps), might allow for improved dietary tracking adherence. The authors assessed the use of a popular smartphone app for dietary self-monitoring and weight loss by comparing it with traditional diet counseling and entry methods.
Methods: Diet tracking and weight loss were compared across participants during an 8-week weight loss trial. Participants tracked intake using 1 of 3 methods: the mobile app “Lose It!”, the memo feature on a smartphone, or a traditional paper-and-pencil method.
Results: App users (n = 19) recorded dietary data more consistently compared with the paper-and-pencil group (n = 15; P = .042) but not the memo group (n = 13). All groups lost weight over the course of the study (P = .001), and no difference in weight loss was noted between groups.
Conclusions and Implications: Smartphone apps could represent a novel and feasible dietary self-monitoring method for individuals.
Key Words: smartphones, apps, weight loss, dietary self-monitoring (J Nutr Educ Behav. 2014;46:440-444.)

INTRODUCTION
Assessment tools such as food frequency questionnaires, 24-hour dietary recalls, and food records are means for establishing trends in caloric intake and dietary patterns that may influence weight regulation over time. Although these assessment tools are used extensively by researchers and nutrition professionals to track food intake, diet monitoring faces obstacles that reduce the accuracy of data collection. In particular, diet monitoring is compromised by reliance on accurate recall, lack of consistency of reporting, and the overall burden of data logging.1 Yet, at the individual level, dietary self-monitoring has been identified as one of the most successful tools for managing body weight among individuals.2-4

Innovations in dietary monitoring technology are emerging with the intent of improving accuracy of data collection and analysis as well as reducing the burden of self-monitoring on individuals.1,2 Many of these new technologies incorporate Internet-based dietary self-monitoring for behavior change interventions.5-7 These modalities have been shown to be effective, but computer-based monitoring still requires individuals not only to rely on memory, but also to take time at a computer to log data.8

More recently, with the advent of mobile technologies, including smartphones, tablets, and other handheld devices, the possibilities for rapid dietary data logging and real-time dietary analysis are growing. Roughly 83% of Americans now own a mobile phone.9

Of these, 45% own smartphones with Internet access, up dramatically from 18% in 2009.10 These newer technologies offer unprecedented opportunities for individual-level data collection. Furthermore, they can be tailored to implement educational and other health behavior change interventions. In particular, health-related applications, or apps, commonly used on smartphones permit individuals to record personal and dietary data with relative ease.11,12 They can also provide immediate feedback to aid users in achieving particular health-related goals. In addition, smartphones are often consistently used for multiple daily functions. As such, the technology might offer a more accessible platform for self-monitoring and dietary data entry compared with Web sites or other diet-tracking methods. Recent research suggested that individuals, especially those of younger generations, preferred the use of mobile phones for dietary and weight loss interventions compared with other Web-based tools.13

The literature base has grown related to mobile device use for
dietary data collection and behavior change interventions, much of which has focused on personal digital assistants (PDAs). However, this technology is quickly being replaced with smartphones running mobile app technology that allows for real-time health-related and other data collection. To date, little research has documented the extent to which health-focused apps on smartphones are useful from the user’s perspective or feasible in terms of self-monitoring of dietary intake. Further, little is known about whether the most recent mobile app technologies offer a superior platform for data collection compared with more traditional methods of diet tracking. The purpose of this pilot weight-loss study was to compare the feasibility of diet recording using the commercially available smartphone app “Lose It!” with standard diet recording and counseling methods, using either traditional paper-and-pencil methods or the use of text-based smartphone memo functionality. Researchers hypothesized that use of a smartphone app would lead to increased compliance in tracking caloric consumption, as measured by full days of diet recording, compared with either the smartphone memo method or a paper-and-pencil diet-tracking method. It was further hypothesized that smartphone app users would demonstrate lower rates of attrition from the study, as well as a greater degree of weight loss, compared with the paper-and-pencil group.

METHODS
Participants
Healthy, weight-stable adults (18–65 years of age; body mass index [BMI], 25–40 kg/m²) who owned smartphones were recruited from a campus community to participate in an 8-week weight loss trial (Table). Participants (n = 57) were free of unresolved medical conditions and did not take medications or supplements known to affect body weight. All participants reported no dieting or weight changes of greater than ± 5 lb in the past 3 months and agreed to record all food intake during the trial using their smartphone or a paper-based diet log. All participants provided written informed consent, and the Arizona State University Institutional Review Board approved the study.

Design
Participants were stratified by age, BMI, and gender and semi-randomized into 3 groups: the app group (AP) (n = 19), trained to use the diet-tracking “Lose It!” app daily; the memo group (ME) (n = 18), trained to track dietary intake daily through use of the memo function on their smartphones; and the paper group (PA) (n = 20), trained to record dietary intake daily using a traditional paper-and-pencil method. Because the app was available only on iPhones at the time of the study, only participants with iPhones could be placed in the “Lose It!” app group. Before the start of the study, all participants completed a written food record for 3 consecutive days, including 1 weekend day. At the start of the study, participants met with investigators for anthropometric measurements and to complete a short health history, which included questions on health, recent dieting and weight loss, and use of medications and/or supplements. Customary physical activity data were gathered using a standard physical activity questionnaire, and activity was calculated by multiplying the number of weekly exercise and walking episodes by the intensity index expressed in metabolic equivalent (MET) values (9, 5, and 3 METS for vigorous, moderate, and mild exercise, respectively). The AP group recorded dietary intake using the “Lose It!” app interface, which provided a large database of commonly consumed foods for users to search and add to a diary at each eating occasion. It also provided immediate feedback in the form of a daily calorie gauge graphic that increased in real-time as foods were entered. The “Lose It!” app calculated the daily energy allotment for the user based on a pre-identified weight loss goal (1 lb/wk) and individual anthropometric data. No dietary advice was provided to the AP group; however, these participants received immediate feedback regarding calorie intake when dietary data were entered into the “Lose It!” app.

Table. Selected Baseline Characteristics of Study Participants, by Diet Assessment Technique Group

<table>
<thead>
<tr>
<th>Diet Assessment Technique Group</th>
<th>iPhone App</th>
<th>Smartphone Memo</th>
<th>Paper/Pencil</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, male/female</td>
<td>6/13</td>
<td>2/11</td>
<td>4/11</td>
<td>.58</td>
</tr>
<tr>
<td>Age, y</td>
<td>43.7 ± 3.5</td>
<td>41.5 ± 4.0</td>
<td>40.8 ± 3.6</td>
<td>.83</td>
</tr>
<tr>
<td>Weight, lb</td>
<td>185.7 ± 6.8</td>
<td>189.9 ± 11.6</td>
<td>181.3 ± 10.0</td>
<td>.82</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td>29.9 ± 0.9</td>
<td>31.0 ± 1.7</td>
<td>28.9 ± 1.0</td>
<td>.52</td>
</tr>
<tr>
<td>PA score (METs × frequency/wk)</td>
<td>35.8 ± 6.3</td>
<td>38.4 ± 7.1</td>
<td>31.4 ± 4.4</td>
<td>.73</td>
</tr>
<tr>
<td>Daily energy, kcal</td>
<td>1,791 ± 181</td>
<td>1,997 ± 266</td>
<td>2,163 ± 129</td>
<td>.42</td>
</tr>
<tr>
<td>Total HEI score</td>
<td>63.9 ± 3.8</td>
<td>59.8 ± 3.5</td>
<td>61.1 ± 2.5</td>
<td>.68</td>
</tr>
<tr>
<td>Whole-grain HEI score</td>
<td>2.4 ± 0.6</td>
<td>1.7 ± 0.5</td>
<td>1.8 ± 0.4</td>
<td>.69</td>
</tr>
<tr>
<td>Vegetable HEI score</td>
<td>3.0 ± 0.4</td>
<td>2.5 ± 0.4</td>
<td>3.0 ± 0.3</td>
<td>.57</td>
</tr>
<tr>
<td>Fruit HEI score</td>
<td>3.6 ± 0.4</td>
<td>3.3 ± 1.4</td>
<td>3.1 ± 0.5</td>
<td>.89</td>
</tr>
<tr>
<td>Saturated fat HEI score</td>
<td>6.2 ± 1.0</td>
<td>5.9 ± 0.5</td>
<td>7.0 ± 1.0</td>
<td>.68</td>
</tr>
<tr>
<td>Sodium HEI score</td>
<td>4.1 ± 0.8</td>
<td>3.7 ± 0.7</td>
<td>6.0 ± 0.7</td>
<td>.08</td>
</tr>
</tbody>
</table>

HEI indicates Healthy Eating Index; MET, metabolic equivalent; PA, paper group. 
1 MET corresponds to an energy expenditure of 1 kcal · kg⁻¹ · h⁻¹. Dietary data for subset of sample with complete pre and post 3-day diet records (n = 10, 10, and 11 for iPhone app, smartphone memo, and paper-and-pencil groups, respectively).

Note: Data represent means ± standard error. P was derived from 1-way analysis, except for gender, where chi-square analysis was used. There were no significant differences between groups.
Conversely, participants in the ME and PA groups received feedback by attending one-on-one nutrition counseling sessions before the start of the study and received weekly e-mails during the study to encourage healthy eating. A personalized written diet plan was developed for each ME and PA participant. Diet plans were structured using the exchange system and the Dietary Guidelines for Americans to establish energy intakes that would achieve 1 lb/wk weight loss.\(^{16,17}\) These were calculated using the Mifflin-St. Jeor equation for resting metabolic rate.\(^{18}\) All study participants were instructed to expend about 150 cal/d via structured exercise, and participants were instructed to record dietary intake only for the present day, but not for any previous days.

To allow investigators to track dietary intake, the AP group programmed their smartphones to send automatic daily reports to researchers for data entry. The ME group e-mailed their recorded daily food intake as a memo each night. The PA group recorded daily food intake using a notebook provided by the researchers and submitted the notebook at study weeks 4 and 8. Each group was instructed not to retro-record missed days (ie, participants were to record dietary intake only for the present day, but not for any previous days).

To determine consistency of daily dietary tracking, investigators used dietary intake data to calculate daily kilocalorie intake (or, in the case of dietary tracking, investigators used dietary intake data to calculate daily kilocalorie intake) including total kilocalorie intake for the present day, but not for any previous days.

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Ten participants did not complete the trial (5 ME and 5 PA participants); 1 participant was lost to follow-up and the remainder cited personal issues, such as time constraints. This resulted in a total of 47 participants. No differences for gender, age, weight, or BMI were noted between individuals who persisted in the study and those who withdrew (data not shown). However, attrition between groups was significantly different (P = .05, chi-square test). The AP group, in which no attrition occurred, differed from both the ME and PA groups, but the ME and PA groups did not differ from each other. Baseline measures of demographic characteristics, energy intake, activity level, and overall and selected HEI scores did not differ between study groups (Table).

Univariate analyses revealed that the number of complete days of dietary data recorded differed between groups (unadjusted P = .04; effect size = 0.135). Age was strongly correlated with complete days recorded (r = 0.427; P = .003); however, a significant difference remained after controlling this confounder (adjusted P = .05; effect size = 0.134). Post hoc analyses showed that the AP group recorded significantly more complete days than the PA group (43.0 ± 2.5 and 30.7 ± 4.6 days, respectively; P = .024; effect size = 0.153), but no differences were noted between the ME (34.8 ± 3.5 days) and PA groups, or between the AP and ME groups. The number of missing days during which no recording occurred also varied by group; both the ME and PA groups reported twice the number of missing days as the AP group (21.0 ± 4.9, 21.3 ± 3.4, and 10.3 ± 2.1 days, respectively; P = .04; effect size = 0.136).

Both change in weight and HEI scores were assessed across the 8-week trial. There was a significant reduction in body weight across groups at the end of the 8-week trial (−3.5 ± 1.0, −6.5 ± 1.4, and −4.4 ± 1.2 lb for AP, ME, and PA groups, respectively; mean weight loss, −4.6 ± 0.7 lb, P < .001; effect size = 0.542); however, mean weight loss did not differ between groups at the end of the trial (P = .19; effect size = 0.073). Similarly, BMI values were reduced at the end of the 8-week trial across groups (mean reduction in BMI: −1.4 ± 0.6 kg/m², P = .09; effect size = 0.122) but there were no group differences (P = .36; effect size = 0.046). Six participants categorized as overweight at the start of the trial moved to the normal weight category at the end of the trial, and 2 participants categorized as obese at the start of the trial moved to the overweight category at the end of the trial. Hence, BMI weight category improved for 17% of the study participants during the trial. The HEI scores did not change for any group across 8 weeks (P = .25; effect size = 0.097). However, total HEI scores fell slightly (−6%) in the AP group and rose slightly in the other groups (+3% and +9% for the ME and PA groups, respectively) (P = .29; effect size = 0.089) (Figure). This pattern was also noted for selected HEI categories, including whole grains, total fruit, saturated fat, and sodium.

**RESULTS**

**DISCUSSION**

Success of mobile devices for self-monitoring will depend in part on the extent to which they facilitate more consistent data entry, which may be important both for increased commitment to dietary behavior change interventions as well as for resultant health outcomes and weight management. In this study, participants using a commercially available...
app more consistently entered complete days of dietary data compared with the paper-and-pencil group. App users also withdrew from the study less often compared with the other groups. It is possible that app technology offers a less burdensome method for tracking data compared with paper-and-pencil tools. Also, because individuals often carry smartphones for the variety of other functions they offer, employing smartphone-based tools may prove to be a simpler, scalable intervention strategy compared with standard tracking methods.

Although weight loss from baseline to 8 weeks was significant in all groups in this study, no difference in weight loss was noted between groups. These data suggest that app use for dietary tracking might be a successful tool to support weight loss. Future research should focus on the use of weight loss apps with or without accompanying diet counseling to determine effects on weight loss and diet quality outcomes. A number of recent longer-term interventions incorporating PDA devices with on-board health behavior tracking programs, rather than smartphone apps, suggest as much. Burke and colleagues found that participants who used PDAs for dietary self-monitoring in a 6-month weight-loss trial were successful at weight loss; however, those who used PDAs while also receiving feedback messages more often achieved a higher percentage weight loss compared with participants using a paper-and-pencil method of self-monitoring. More recently, Spring and colleagues found that use of a PDA-based diet-tracking system, in combination with a telephone-based counseling program, significantly improved weight loss over the course of 12 months among overweight and obese adults, compared with a counseling program alone.

To improve diet quality, combining strategies such as diet counseling with mobile technology should be considered. Overall HEI scores as well as select HEI categories trended downward for app users in this study, but trended upward for memo and paper-and-pencil users who received weekly diet encouragement. Hence, although weight loss was similar between groups, diet quality was not improved in the AP group, which suggests the importance of counseling sessions to discuss diet principles. In a 6-month weight-loss study, Acharya and colleagues found that participants using a PDA for dietary self-monitoring plus

**IMPLICATIONS FOR RESEARCH AND PRACTICE**

To date, much of the research on use of mobile technology for dietary self-monitoring has focused on PDAs, which can differ substantially from smartphones in terms of total functionality and ease of use. Smartphones combine traditional functions of phone and text communications with novel technologies such as apps, and they are quickly becoming a primary form of communication and information exchange. Data from this study suggest that smartphone apps could be a feasible tool for consistent dietary self-monitoring for weight loss or weight management. However, it is possible that smartphone apps that provide feedback only in the form of calories consumed, and not in relation to
dietary quality, fail to give users enough information to improve the healthfulness of their diet while also managing weight. Further research is necessary to identify properties of smartphone apps that are associated with accurate and consistent dietary data collection and self-monitoring.\(^5,26,27\) As such, food and nutrition professionals should consider using app technology in conjunction with dietary counseling for weight management.

**ACKNOWLEDGMENTS**

Funding for this study was provided by the Nutrition Fund of the Arizona State University Foundation. The authors acknowledge David Kevin Cowan for work on dietary quality assessments for this project.

**REFERENCES**


