Comparison of traditional versus mobile app self-monitoring of physical activity and dietary intake among overweight adults participating in an mHealth weight loss program

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ABSTRACT

Objective Self-monitoring of physical activity (PA) and diet are key components of behavioral weight loss programs. The purpose of this study was to assess the relationship between diet (mobile app, website, or paper journal) and PA (mobile app vs no mobile app) self-monitoring and dietary and PA behaviors.

Materials and methods This study is a post hoc analysis of a 6-month randomized weight loss trial among 96 overweight men and women (body mass index (BMI) 25–45 kg/m^2) conducted from 2010 to 2011. Participants in both randomized groups were collapsed and categorized by their chosen self-monitoring method for diet and PA. All participants received a behavioral weight loss intervention delivered via podcast and were encouraged to self-monitor dietary intake and PA.

Results Adjusting for randomized group and demographics, PA app users self-monitored exercise more frequently over the 6-month study (2.6±0.5 days/week) and reported greater intentional PA (196.4±45.9 kcal/day) than non-app users (1.2±0.5 days/week PA self-monitoring, p<0.01; 100.9±45.1 kcal/day intentional PA, p=0.02). PA app users also had a significantly lower BMI at 6 months (31.5±0.5 kg/m^2) than non-users (32.5±0.5 kg/m^2; p=0.02). Frequency of self-monitoring did not differ by diet self-monitoring method (p=0.63); however, app users consumed less energy (1437±188 kcal/day) than paper journal users (2049±175 kcal/day; p=0.01) at 6 months. BMI did not differ among the three diet monitoring methods (p=0.20).

Conclusions These findings point to potential benefits of mobile monitoring methods during behavioral weight loss trials. Future studies should examine ways to predict which self-monitoring method works best for an individual to increase adherence.

BACKGROUND AND SIGNIFICANCE

Self-monitoring of physical activity (PA) and dietary intake are key components of behavioral weight loss programs.[1] Self-monitoring of PA, which includes recording frequency, intensity, time, and type of activity, is an important component of a weight loss program but can add to participant burden.[2] Self-monitoring of diet requires daily recording of each food consumed and its energy content (and sometimes other macronutrients, such as fat grams). This can also be onerous for participants who often must use a book listing the caloric values of common foods to assess the caloric value of their daily diets.[1] Self-monitoring is important, however, as it is associated with improved weight loss.[3] Generally, studies requiring self-monitoring by participants have utilized paper journal methods.[4] With advances in mobile technologies, studies have started to employ electronic devices for self-monitoring, such as pedometers and arm-band sensors for PA[5] and personal digital assistants (PDAs)[4] for dietary intake. As paper recording methods can be time consuming and tedious for participants,[6] using mobile devices for self-monitoring holds promise for making self-monitoring easier (through automatic calculation of energy intake and expenditure) and presents an opportunity for real-time self-monitoring.

OBJECTIVE

The purpose of this study was to assess if the method of PA (app vs no app) and diet (app, website, or paper journal) monitoring is related to changes in self-monitoring frequency, dietary outcomes, energy expenditure, body mass index (BMI), and body weight. We hypothesized that mobile methods of self-monitoring would be associated with greater self-monitoring frequency, greater energy expenditure, lower energy intake, lower BMI, and greater percent weight loss.

MATERIALS AND METHODS

This paper presents a secondary analysis of data from a 6-month weight loss trial which randomized 96 overweight and obese men and women (BMI=25–45 kg/m^2, 18–60 years old) to receive either a behavioral weight loss intervention delivered by audio podcast only (Podcast group, n=49) or an intervention delivered by the same podcast plus mobile diet monitoring using a diet and PA monitoring app as well as moderator and social support (from fellow study participants) delivered via the social networking site Twitter (Podcast+Mobile group, n=47).[7] The study was conducted between 2010 and 2011 in the Raleigh-Durham area of North Carolina. Participants were recruited using e-mail listservs, newspaper, and television ads. All participants were required to have an internet-capable mobile device (iPhone, iPod Touch, BlackBerry, or Android-based phone) to participate in the study. Participants were excluded if they had an unstable medical status, were unable to increase duration of walking as a form of exercise, or were currently participating in a weight loss program. Participants were also required to be able to complete the Physical Activity Readiness Questionnaire[8] and were excluded if they had a history of myocardial infarction or stroke and had to obtain physician consent for participation if answering yes on other items (such as use of hypertensive medications or bone and joint issues).

Participants in both groups received the same twice weekly podcasts (audio files that can be downloaded to a mobile device or desktop computer) that covered behavioral weight loss topics, including how to self-monitor diet and incorporate PA into daily routines (there were a total of 24 podcasts over the course of the 6-month study). All participants were encouraged to self-monitor their diet, PA, and weight and reported self-monitoring behaviors and body weight each week via an online questionnaire. The intervention was delivered entirely by remote means. Participants only came to the study site and interacted with study personnel for assessments at baseline, 3 months, and 6 months. No individual feedback was provided on self-monitoring or any other behaviors over the course of the study. More details on the methods and results of the main weight loss intervention can be found elsewhere.[7] The University of North Carolina at Chapel Hill Institutional Review Board approved the study protocol and all participants provided written informed consent.

Podcasts used in the study emphasized the importance of self-monitoring diet and exercise and instructed participants on how to calculate energy goals for a caloric deficit of ≥500 kcal/day to encourage a weight loss of 1–2 lbs/week and decrease dietary fat intake to less than 30% of total energy. Podcasts also encouraged participants to limit added sugar intake and increase fruit and vegetable consumption. PA goals discussed on the podcasts included incorporating a minimum of 30 min of moderate-to-vigorous exercise each day, and encouraged participants to work up to this goal over the first 4 weeks of the study. In order to encourage self-monitoring of diet and exercise, the Podcast+Mobile group was instructed to install the 'Fat Secret' calorie and exercise monitoring app[9] on their mobile device (or other mobile diet and PA apps that they preferred) and the Podcast group was given a book with the calorie and fat gram amounts of common foods (The Ultimate Calorie Counter)[10] and was told to use this book to record caloric intake and to record PA, both using a paper journal. Participants in both groups, however, had mobile devices, which allowed them to use a self-monitoring method of their choosing, including mobile apps to be used on smartphones, diet tracking websites traditionally accessed via desktop computer, or traditional paper journals. While participants in the Podcast and the Podcast +Mobile groups were encouraged to use different self-monitoring methods, participants were free to use the method that worked best for them or that they preferred. Participants were told to self-monitor everything they ate and drank (in order to stay within their energy intake goals) and record all bouts of intentional PA.

Participants reported their frequency of self-monitoring of diet and PA on a weekly survey. Weekly surveys asked participants to report body weight, number of podcasts listened to and the topics covered on those podcasts, number of days diet was self-monitored, number of days that PA was self-monitored, and, for the Podcast+Mobile group, participation in Twitter. Missing data on self-monitoring on the weekly survey were treated as zero days of self-monitoring for that week (eg, no survey completed for week 11 for a participant meant 0 days of self-monitoring of diet and PA were recorded for week 11 for that participant). On the 6-month survey, participants were asked to report the primary self-monitoring method that they used most often over the course of the study. For diet self-monitoring, participants were asked to select their main method for self-monitoring: paper journal, diet website, mobile app, or no method used. Participants were also asked to write in the name of the mobile app or website used. Since most technology used to track PA is moving towards mobile apps (since mobile devices can be used to objectively and unobtrusively track PA as it occurs as opposed to diet, which must be manually recorded, regardless of self-monitoring method used), participants were asked if they used a mobile PA app to self-monitor PA (and what the name of the app was) or did not use an app for PA self-monitoring. Although participants may have changed methods during the study, the primary focus of this analysis is on the method participants cited that they used most often over the course of the 6-month study.

Participants completed assessments at baseline, 3 months, and 6 months when their height was measured (baseline only), they were weighed, and they completed questionnaires, including 2 days of unannounced 24 h dietary recalls (1 weekday and 1 weekend day) collected using the Automated Self-administered 24-Hour Dietary Recall (ASA24),[11] which assessed energy intake, percent energy from fat, added sugar (teaspoons/day), and fruit and vegetable (cups/day) consumption. Information was also gathered on intentional PA (kcal/day) using the Paffenbarger Physical Activity Questionnaire, a survey instrument which assesses leisure time activity in adults over the previous week,[12] and on eating behaviors that are associated with weight loss using the 26-item Eating Behaviors Inventory (EBI), which assesses both positive behaviors associated with weight loss and negative behaviors associated with weight gain.[13] Both the Paffenbarger Questionnaire[14] and the EBI[13] are validated measures. In the main trial, there was no difference between the Podcast or Podcast+Mobile groups regarding changes in body weight, energy intake, percent energy from fat, PA, self-monitoring frequency, study adherence, or EBI score at 3 or 6 months.[7] Therefore, for the present substudy, both groups were collapsed for all analyses.

Statistical methods

For continuous demographic variables, analysis of variance (ANOVA) was used to examine mean differences in variables among the three self-monitoring methods and t tests were used to examine mean differences between the PA app users versus those who did not use a PA app. Demographic information that contained multiple categories was dichotomized: education was dichotomized as college degree versus no college degree and ethnicity was dichotomized as white versus other. A χ^2 test of independence was used to assess differences among categorical variables at baseline and to examine differences in demographics between those who reported a self-monitoring method and those who did not. Univariate general linear models (GLM) were used to assess differences in outcome variables by PA self-monitoring method, adjusting for demographic variables, baseline value of outcome variable, and original randomized group assignment (Podcast vs Podcast+Mobile). GLM models examining 6-month dietary outcomes by type of diet monitoring method were adjusted for initial randomized group, baseline intakes of the examined outcome, demographics, and also interaction terms for diet monitoring method and race, and diet monitoring method and gender. GLM models were also used to examine the relationship of days of diet self-monitoring with percent weight loss and of energy intake and change in PA with percent weight loss. Post hoc analyses were conducted using least-significant difference pairwise comparisons.

Only participants who reported use or non-use of a PA app on the 6-month survey were included in the PA self-monitoring analysis and only those who reported a diet self-monitoring method on the 6-month survey were included in the diet self-monitoring analysis. Use of a PA app was dichotomized into 'used an app to monitor PA' (PA app user) or 'did not use an app' (non-PA app user). Dietary self-reporting methods were categorized into three different groups: paper journal, app, or website. Those who reported they did not use any self-monitoring monitoring method or failed to complete the 6-month questionnaire providing this information were excluded from diet monitoring analyses. Main outcomes of interest that were measured at the three assessment visits, such as BMI, % weight loss, and dietary variables, were imputed using baseline observation carried forward. All analyses were conducted using Statistical Package for the Social Sciences 19.0 for Windows software with a p value of <0.05 used to indicate statistically significant differences (V.19.0, 2010; SPSS, Inc., Chicago, Illinois, USA).

RESULTS

At 6 months, of the 96 participants who began the trial, 86 (90%) had their weight assessed (the main outcome), 83 (86%) completed 2 days of diet recall, and 84 (88%) completed PA and EBI questionnaires. Regarding diet self-monitoring, 81 (84%) participants reported a diet self-monitoring method on the 6-month survey, with 78 (81%) who reported use of one of the three examined diet self-monitoring methods (app, website, or paper journal) being included in the diet self-monitoring analyses. The 85 (89%) participants who reported use or non-use of a PA monitoring app were included in the PA self-monitoring analyses. Although only Podcast+Mobile group participants were instructed to use an app to monitor diet and PA, 33% (13 of 39) of Podcast participants reported using an app to monitor their diet and 43% (19 of 44) reported using an app to track PA. There were 48 PA app users (56%) and 37 non-PA app users (44%) (11 did not respond). There were 17 participants who used paper journals (22%), 37 who used a diet app (47%), and 24 (31%) who used a website. Those who reported they did not use any dietary monitoring method (n=3) or failed to complete the questionnaire providing this information (n=15) were excluded from diet monitoring analyses. There was no difference between those who reported a self-monitoring method for diet or for PA by education or gender, but there was a difference by ethnicity. More black participants did not report a PA self-monitoring method (χ^2=10.74; p = 0.001) or a diet self-monitoring method (χ^2=12.14; p < 0.001) at 6 months than white participants.

The three most commonly used PA monitoring apps were RunKeeper, Fat Secret's Calorie Counter, and My Fitness Pal. The three most popular diet tracking apps used in the study were Fat Secret's Calorie Counter, My Fitness Pal, and Lose it. The three most common diet tracking websites were MyFitnessPal.com, MyFoodDiary.com, and SparkPeople.com. There were no significant differences in baseline demographics, BMI, or energy intake or expenditure between exercise app users and non-users. While there were also no statistically significant differences in demographics among the three different diet monitoring types, diet apps did appear to be used more frequently by men and less by black participants than other monitoring methods (see table 1).

All results are presented as adjusted means±SE. Adjusting for randomized group, age, race, gender, and education, those who used an app to self-monitor PA recorded exercise more frequently over the 6-month study (as reported on weekly questionnaires) than those who did not (2.6±0.5 days/week for app users versus 1.2±0.5 days/week for non-app users; p=0.001) (table 2). Controlling for demographics and baseline intentional energy expenditure, PA app users reported a higher level of intentional PA at 6 months (196.4±45.9 kcal/day) than non-app users (100.9±45.1 kcal/day; p=0.02). PA app users also had a significantly lower BMI at 6 months (31.5±0.5 kg/m^2) than non-users (32.5±0.5 kg/m^2; p=0.02). PA app users lost more weight (−3.7±1.5%) than non-app users (−0.5±1.5%) at 6 months (p=0.01). Change in PA (adjusting for race, age, gender, and randomized group) was significantly related to percent weight loss at 6 months (F (6,95)=19.32; p<0.001).

Adjusting for covariates, the relationships between the three different diet monitoring methods and self-monitoring

Table 1 Baseline demographic data by diet and physical activity self-monitoring method in a 6-month, behavioral weight loss intervention delivered by podcast

	Physical activity self-monitoring method (n=85)		Diet self-monitoring method (n=78)		
	Used an app	Did not use an app*	Mobile app	Paper journal	Website*
n	48 (56%)	37 (44%)	37 (47%)	17 (22%)	24 (31%)
Age, years (mean±SD)	44.0±1.6	44.2±1.6	41.3±11.5	47.2±8.9	45.4±9.9
Sex, n (%)					
Male	11 (23%)	10 (27%)	11 (30%)	4 (24%)	3 (13%)
Female	37 (77%)	27 (73%)	26 (70%)	13 (76%)	21 (87%)
Race/ethnicity, n (%)					
Black or other	7 (15%)	9 (24%)	3 (6%)	5 (36%)	5 (26%)
White	41 (85%)	28 (76%)	34 (94%)	12 (64%)	19 (74%)
Education, n (%)					
College or less	3 (6%)	3 (13%)	1 (3%)	2 (12%)	2 (8%)
Graduate degree	45 (94%)	34 (87%)	36 (97%)	15 (88%)	22 (92%)
Body mass index, kg/m^2	32.5±0.6	32.6±0.8	31.8±4.2	33.1±4.0	33.0±5.5
Energy intake, kcal/day	1994±84	2001±132	2092±622	1699±584	1980±630
Energy expenditure from intentional activity, kcal/day	129±17	93±16	116±101	153±121	101±114

Data are mean±SE or n (%) unless otherwise indicated.
*There were no significant differences between the two physical activity app groups or among the three types of diet monitoring methods on any of the baseline characteristics.

Table 2 Differences in days/week of self-monitoring, physical activity, and BMI by physical activity self-monitoring method at 6 months

Physical activity monitoring	Mobile PA app	No PA app used	Overall model significance level	p Value for type of monitoring method*
n	48	37		
Mean days/week of PA self-monitoring	2.6±0.5†	1.2±0.5	F (6,84)=2.48; p=0.03	F (6,84)=12.44; p=0.001
Intentional PA, kcal/day	196.4±45.9†	100.9±45.1	F (7,84)=2.80; p=0.01	F (7,84)=5.82; p=0.02
BMI, kg/m^2	31.5±0.5†	32.5±0.5	F (7,84)=72.33; p<0.001	F (7,84)=5.73; p=0.02

Data are mean±SE.
*p Value is for differences between PA app use versus non-use using univariate general linear models for 6-month outcomes. All models were adjusted for the baseline value of the examined 6-month outcome, age, race, gender, education, and original randomized group (Podcast vs Podcast+Mobile).
†Significantly different from those who did not use an app for PA (p<0.05).
BMI, body mass index; PA, physical activity.

frequency were not significantly different (F (11,77)=2.83; p=0.63) (table 3). At 6 months, there was a significant difference among the three diet monitoring methods in energy intake (kcal/day) (p=0.03) as measured by 24 h recalls. Post hoc analyses showed a lower energy intake at 6 months among app users (1437±188 kcal/day) as compared to paper journal users (2049±175 kcal/day; p=0.01). Overall models for percent energy from fat, added sugar, vegetables, EBI, and BMI were significant but diet self-monitoring method was not significantly associated with any of these outcomes, suggesting that other covariates (such as education or age) may have been associated with the examined outcomes. The model was not significant for fruit (p=0.16) (table 3). Average days/week that diet was self-monitored over the 6-month study significantly predicted percent weight loss at 6 months (F (6,95)=73.54; p<0.001) and energy intake (F (6,94)=12.49; p=0.001) such that more days of dietary self-monitoring was associated with greater weight loss and lower energy intake. A total of 78 participants provided information on both diet and PA monitoring methods. Of those, 13 (17%) reported using an app to track both diet and PA. Adjusting for demographics, baseline BMI, and randomized group, those participants using an app to track both diet and PA did not lose more weight than those using a combination of methods (p=0.42).

Adjusting for demographic variables and group assignment, the total number of podcasts (out of 48) that participants reported downloading over 6 months was greater in the PA app group (26.1±3.6) than in non-users (17.1±3.4; p=0.004). Number of podcast downloads did not differ among paper journal (23.8±5.3), diet app (28.6±5.7), and diet web (21.0±5.6) users (p=0.52). The number of podcasts downloaded was significantly related to both the average days/week diet (F=71.8; p<0.001) and PA (F=65.5; p<0.001) were self-monitored. This suggests that adherence to study-related components (as reflected through downloading podcasts) was related to both diet and PA self-monitoring frequency and use of a PA app.

DISCUSSION

Mobile methods of PA self-monitoring are a recent addition to self-regulation methods for weight loss. Self-monitoring exercise has been shown to be related to weight loss.[15] Most trials examining PA self-monitoring frequency have used paper journals for self-monitoring.[4] In one of the few behavioral weight loss studies examining mobile PA self-monitoring, researchers found that a wearable, mobile sensor to self-monitor PA enhanced a behavioral weight loss intervention over no electronic PA monitoring.[16] In the present study, it is unknown whether use of a mobile app helped to increase adherence to PA recommendations or if those who were meeting PA recommendations were more likely to use a mobile app. In addition, a participant who reported self-monitoring diet may not be meeting calorie goals (eg, a participant records eating a meal at a restaurant that exceeds their prescribed energy limits for the day, which is a negative step towards meeting their daily energy intake limits). On the other hand, someone who recorded exercise did in fact complete a bout of PA and therefore met or worked towards PA goals (eg, a participant records a 15 min walk, which is a positive step towards meeting their daily energy expenditure goals).

Table 3 Differences in days/week of self-monitoring, BMI, dietary variables, and Eating Behavior Inventory score by diet self-monitoring methods at 6 months

Dietary monitoring	Mobile diet app	Paper journal	Web site	Overall model significance level	p Value for type of monitoring method*
n	37	17	24		
Mean day/week of diet self-monitoring	3.4±0.8	1.6±0.7	2.1±0.8	F (11,77)=2.83; p=0.63	F (11,77)=2.83; p=0.14
Energy intake, kcal	1437±188†	2049±175	1834±185	F (12,76)=4.71; p<0.001	F (12,76)=3.89; p=0.03
Fat, % kcal	34.6±2.7	35.3±2.5	31.7±2.6	F (12,76)=2.25; p=0.02	F (12,76)=0.72; p=0.49
Added sugar, tsp/day	5.8±2.9	10.2±2.6	9.2±2.8	F (12,76)=2.73; p=0.005	F (12,76)=0.95; p=0.39
Fruit, cups/day	1.4±0.3	1.6±0.3	1.1±0.3	F (12,76)=1.47; p=0.16	F (12,76)=0.77; p=0.47
Vegetables, cups/day	2.2±0.4	2.6±0.3	2.4±0.4	F (12,76)=2.87; p=0.003	F (12,76)=0.41; p=0.67
Eating Behavior Inventory score	90.8±4.7	84.9±4.3	84.4±4.6	F (12,77)=3.22; p=0.001	F (12,77)=0.81; p=0.45
Body mass index, kg/m^2	31.0±0.8	32.5±0.7	32.3±0.8	F (12,77)=36.36; p<0.001	F (12,77)=1.64; p=0.20

Data are mean±SE.
*p Value is for differences among the three different diet monitoring types using univariate general linear models for 6-month outcomes. All models were adjusted for the baseline value of the examined 6-month outcome, age, race, gender, education, original randomized group (Podcast vs Podcast+Mobile), and interaction terms for monitoring method and race, and monitoring method and gender.
†Significantly different from the paper journal group (p<0.05).
BMI, body mass index; tsp, teaspoon.

Therefore, reported PA app use and meeting PA goals would be more tightly linked than reporting diet app use and meeting diet goals.

Mobile methods of dietary self-monitoring (use of an app) may allow for real-time recording of food consumption combined with the convenience of automatically calculating the caloric value of foods eaten (vs looking up foods in a calorie book and adding the value of the items manually). This combination of the best attributes of both paper monitoring (portability) and web methods (automatic calculation of food entries) may make mobile methods (such as apps) advantageous over web (use of a laptop or desktop computer to access diet websites) or paper methods. Mobile apps may allow for more proximal recording of dietary intake data, which is related to greater weight loss.[17] In addition, participants who use traditional, paper methods of self-monitoring often find the use of a calorie book and calculation of all foods eaten to be tedious, time-consuming, and burdensome.[18] Mobile apps can reduce the burden on participants by eliminating the need to calculate energy (or fat gram) totals. In addition, since users are already carrying around their mobile device, use of an app means they do not also have to carry around a calorie book and paper journal. Studies exploring mobile diet monitoring methods, however, have had varying results. For example, one study found no differences in weight loss between PDA and paper journal users (which was similar to the present findings) but found greater adherence to diet self-monitoring in PDA users,[6] which was not observed in the present study after adjustment for potential confounders. Diet outcomes have varied among studies using PDAs with improvements seen for example in fruits and vegetables,[19] percent energy from fat,[20] and saturated fat consumed.[6] The present study did not find improvements in these outcomes; however, those who used a mobile app for diet self-monitoring reported consuming less energy at 6 months than paper journal users. Other studies, which employed PDAs for dietary monitoring, did not find a significantly lower energy intake among PDA users.[6 20 21] The lower energy intake in the present study among app users could have been the result of several factors. For example, an app may have made self-monitoring easier since food items entered could be automatically calculated (as opposed to paper journals) and could be used whenever the participants consumed food, regardless of location (as opposed to web methods). It is also possible that those who were more engaged in the study may have gravitated toward using an app to monitor diet. Since the entire intervention (podcast, Twitter, etc) revolved around mobile delivery methods, those who enjoyed receiving information by mobile methods may have been more likely to also use mobile methods for self-monitoring.

The results of this study suggest that the use of mobile methods for tracking PA and diet is associated with increased energy expenditure and decreased energy intake in individuals who are trying to lose weight. It is important to note that the mean days/week participants reported self-monitoring PA and diet was low, no matter what method was used, pointing to the fact that mobile methods of self-monitoring may not be a solution for increasing adherence. Although participants in the diet app group reported consuming less energy at 6 months, that did not translate into significant differences in BMI among the diet self-monitoring groups at 6 months. Improving adherence through individualization of self-monitoring method is a possible strategy to improve adherence.[18]

Health professionals delivering a weight loss intervention may wish to provide participants with a variety of self-monitoring methods when counseling patients and clients who are interested in weight loss, increasing PA, and changing dietary behaviors. While electronic methods of self-monitoring, particularly mobile methods, appear to have advantages, frequency of self-monitoring was still low regardless of method. Future studies should leverage technology to provide feedback on self-monitoring behaviors as this has been shown to enhance weight loss.[22]

Limitations of this study include the fact that the participants in the three diet monitoring groups and the two exercise tracking groups were not randomized. Rather, participants chose the self-monitoring method. There could have been factors that drew participants to use certain methods (eg, mobile over paper methods) that were not measured and would lead to the differences in outcomes observed. However, demographic characteristics did not differ by monitoring method at baseline despite lack of randomization. Although participants were asked to report their primary self-monitoring method that was used over the 6-month study, they may have used different methods during the study. In addition, for PA self-monitoring, participants were only asked if they used an app or did not use an app, which means the study did not capture other ways to track PA (such as websites or paper journals). Although weight change was an objectively measured outcome, diet, PA, type of monitoring, eating behaviors, and days spent monitoring were all self-reported data. The dietary data were collected by two unannounced, 24 h recalls, which is considered to be an accurate way to measure overall dietary intake[23–25]; for energy expenditure, the Paffenbarger Physical Activity Questionnaire was used which has been shown to be both valid and reliable[14 26]; and for eating behaviors, the EBI was used which has been validated and shown to be related to weight loss.[13] The population for this study was mostly white, educated females, which reduces the generalizability of the findings. Some strengths of this study include the use of validated measures and weekly data collected on both self-monitoring and adherence to the intervention. Participants owned their own mobile device, which allowed them to be familiar with the technology. The results of this study are also applicable outside the research setting in that participants accessed the monitoring method on their own and were not provided with meals, food, or direct access to exercise facilities.

CONCLUSIONS

This study explored interesting relationships among diet and PA self-monitoring method but further, randomized controlled trials will be needed to explore if mobile monitoring methods confer advantages over web or paper journal methods, such as greater number of days diet is self-monitored and greater weight loss. In addition, research is needed to explore ways to provide people with a self-monitoring method that works best for them. Overall, this study points to some advantages of electronic methods for self-monitoring both diet and PA. However, adherence to any form of monitoring in this self-directed study was low, and so future studies should examine ways to make self-monitoring technology more engaging or less burdensome in order to increase adherence. Ways to predict which self-monitoring method works best for an individual are also needed.

Contributors GMT-M: conception and design, acquisition of data, analysis and interpretation of data, drafting of the manuscript, obtaining funding, and supervision; MWB: analysis and interpretation of data, critical revision of the manuscript, and statistical analysis; JBM: conception and design, drafting of the manuscript, and statistical analysis; ATK: conception and design, drafting of the manuscript, and technical support; DJB-A: analysis and interpretation of data, critical

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