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Effectiveness of a Smartphone Application for Weight Loss Compared With Usual Care in Overweight Primary Care Patients

A Randomized, Controlled Trial

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Background: Many smartphone applications (apps) for weight loss are available, but little is known about their effectiveness.

Objective: To evaluate the effect of introducing primary care patients to a free smartphone app for weight loss.

Design: Randomized, controlled trial. (ClinicalTrials.gov: NCT01650337)

Setting: 2 academic primary care clinics.

Patients: 212 primary care patients with body mass index of 25 kg/m² or greater.

Intervention: 6 months of usual care without ($n = 107$) or with ($n = 105$) assistance in downloading the MyFitnessPal app (MyFitnessPal).

Measurements: Weight loss at 6 months (primary outcome) and changes in systolic blood pressure and behaviors, frequency of app use, and satisfaction (secondary outcomes).

Results: After 6 months, weight change was minimal, with no difference between groups (mean between-group difference, -0.30 kg [95% CI, -1.50 to 0.95 kg]; $P = 0.63$). Change in systolic blood pressure also did not differ between groups (mean between-group difference, -1.7 mm Hg [CI, -7.1 to 3.8 mm Hg]; $P = 0.55$). Compared with patients in the control group, those in the intervention group increased use of a personal calorie goal

(mean between-group difference, 2.0 d/wk [CI, 1.1 to 2.9 d/wk]; $P < 0.001$), although other self-reported behaviors did not differ between groups. Most users reported high satisfaction with MyFitnessPal, but logins decreased sharply after the first month.

Limitations: Despite being blinded to the name of the app, 14 control group participants (13%) used MyFitnessPal. In addition, 32% of intervention group participants and 19% of control group participants were lost to follow-up at 6 months. The app was given to patients by research assistants, not by physicians.

Conclusion: Smartphone apps for weight loss may be useful for persons who are ready to self-monitor calories, but introducing a smartphone app is unlikely to produce substantial weight change for most patients.

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It is well-known that the United States is facing an obesity epidemic, and the long-term sequelae are costly (1, 2). Researchers continue to search for effective weight-loss interventions that can be applied in outpatient settings, but these are often time-consuming and resource-intensive, requiring repeated counseling (3). It is no surprise that primary care providers often omit discussing weight loss with obese patients and rarely spend adequate time on counseling (4, 5).

Smartphone applications (apps) may provide an alternative to resource-intensive weight-loss programs. In December 2013, a survey by the Pew Research Center found that 58% of Americans own smartphones and ownership is increasing among every demographic group, including low-income populations (6). The nascent field of mobile health is rapidly expanding; experts estimate that as many

as 40 000 health-related apps were available in 2012, comprising a \$718 million industry (7). Many of these apps aim to help persons change behaviors to improve health, including weight loss, yet few have been rigorously evaluated.

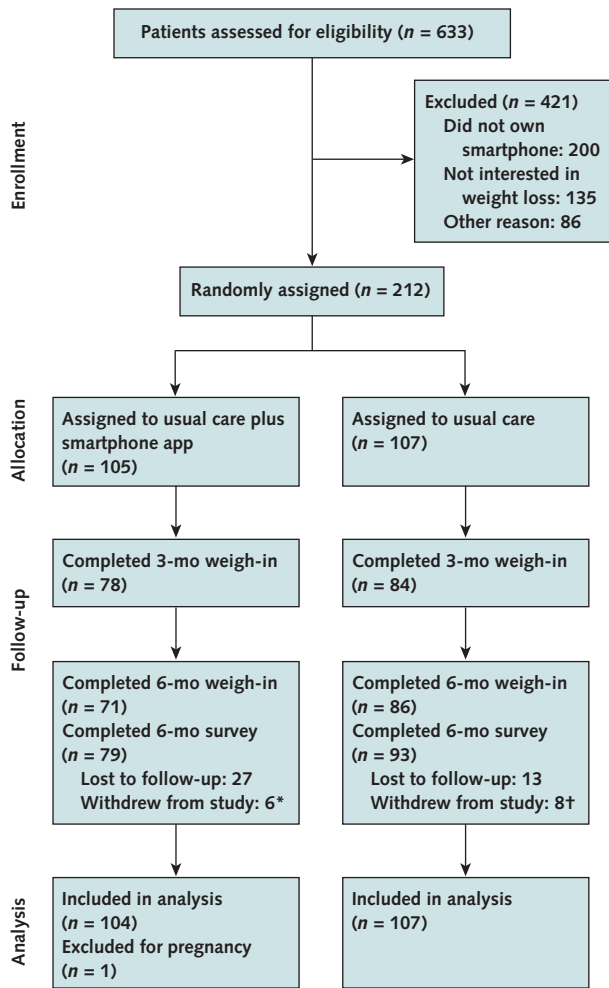
An effective app for reducing body weight could produce tremendous cost savings by preventing long-term complications, such as diabetes and cardiovascular events. To our knowledge, however, no studies have examined the

See also:

Web-Only
Data Supplement

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Figure 1. Study flow diagram.



* Among the 6 intervention group participants who withdrew, 3 reported not having enough time to use the app, 2 did not have time to return for follow-up, and 1 was no longer interested in participating in the study.

† Among the 8 control group participants who withdrew, 6 reported not having time to return for follow-up and 2 were no longer interested in participating in the study.

effectiveness of delivering or prescribing an app for weight loss to patients in a clinical setting.

We evaluated one of the most popular publicly available apps for weight loss: MyFitnessPal (MFP) (MyFitnessPal). MFP has received the highest possible rating, 5 out of 5 stars, from thousands of reviewers on the Apple and Android (Google) app store Web sites. It has nearly 1 million “likes” on Facebook, and the company reports more than 50 million registered users. MFP incorporates elements of social cognitive theory, including self-monitoring, goal setting, and feedback. We sought to test the effect of providing this free, widely used smartphone app for weight loss to patients in their primary care clinic.

METHODS

Design Overview

mFit (The Mobile Fitness Project) was a randomized, controlled trial in which participants were randomly assigned to receive usual primary care ($n = 107$) or usual primary care plus the MFP app ($n = 105$) (Figure 1). Assessments were completed at baseline, 3 months, and 6 months between August 2012 and May 2013. The institutional review board of the University of California, Los Angeles (UCLA), approved the study, and all participants provided written informed consent.

Study data were collected on Apple iPads using Research Electronic Data Capture (REDCap) tools hosted at UCLA. REDCap is a secure, Web-based application designed to support data capture for research studies, providing an intuitive interface, audit trails, and automated export (8).

Setting and Participants

Participants were recruited from 2 UCLA primary care clinics that serve ethnically and socioeconomically diverse patient populations. Eligibility criteria included age 18 years or older, body mass index (BMI) of 25 kg/m² or greater, and smartphone ownership. Participants also had to answer “yes” when asked, “Are you interested in losing weight?” Exclusion criteria were current, planned, or previous pregnancy within 6 months; receipt of hemodialysis; life expectancy less than 6 months; lack of interest in weight loss; or current use of a smartphone app for weight loss.

Screening and Randomization

Patients were recruited during routine primary care visits at their respective clinics. The research team provided a script to medical assistants to use with any patients with BMI greater than 25 kg/m². Patients interested in enrollment were referred to the on-site research assistant, who screened, received consent from, and completed surveys with each patient. Participants were randomly assigned in blocks by BMI of 25 to 30 kg/m² and BMI greater than 30 kg/m² to ensure roughly equal distribution of overweight and obese patients between the intervention and control groups. Our statistician used R (R Foundation for Statistical Computing) to generate the permuted block sequence. We printed the sequence and placed it in opaque envelopes.

Research assistants helped intervention group participants download the MFP app onto their smartphone and showed them an instructional video developed by MFP. These participants also received a telephone call from the same research assistant 1 week after enrollment to assist with any technical problems with the app.

Research assistants told control group patients to “choose any activities you’d like to lose weight,” without specifying any particular interventions. Control group participants were aware that they were participating in a study of a weight-loss app but were blinded to the name of the

app. To minimize contamination of the control group, providers and clinic staff were also blinded to the name of the app and to group assignment.

At the 3-month follow-up visit, all participants received a 1-page educational handout on healthy eating from www.myplate.gov. Participants received a \$20 gift card for attending each follow-up visit. Each participant's primary care provider was notified of their enrollment in the study. Blood pressure was measured at baseline, 3 months, and 6 months by trained research assistants using an automated monitor (Dinamap, GE Medical Systems).

Intervention

We selected MFP as our intervention on the basis of 2 focus groups held with overweight primary care patients. Patients were asked about their impressions of various text message-based programs and smartphone apps. Overall, there was much more interest in smartphone apps than text-based programs. A few participants stated they enjoyed using MFP, and a majority expressed great interest in trying it. Although we selected MFP as our intervention, there are many similar, publicly available apps that may be as popular as MFP. Some of these apps have been assessed in prior studies, but to our knowledge, none have been evaluated in a randomized trial (9).

MFP was designed by software engineers in collaboration with dietitians to create an app for calorie counting. The app provides a database of more than 3 million foods and an easy-to-use interface for logging food and exercise. Users enter their current weight, goal weight, and goal rate of weight loss (limited to 0.23 to 0.90 kg/wk). The MFP app then shows the user their daily, individualized calorie goal. Each day, the app displays the user's calorie goal relative to their recorded caloric intake. MFP also generates real-time reports showing users their weight trend, caloric intake in the past week, and nutritional summaries of their diet (for example, grams of fat, carbohydrates, and protein and milligrams of sodium). The app also includes a bar code scanner for store-bought foods and a social networking feature that enables users to find friends and share their progress. Study participants were encouraged to use the social networking feature with friends and to set reminders to log their food.

MFP incorporates an evidence-based and theory-based approach to weight loss. Setting a realistic weight-loss goal of 0.23 to 0.90 kg/wk is supported in self-regulation theory and is a standard setting of the MFP app (10). The social networking feature of MFP may be important, given prior studies demonstrating the benefits of social support on weight loss (11). Self-monitoring, consisting of recording dietary intake, physical activity, and weight, is also strongly associated with weight loss (12). One pilot trial recently found that adherence to diet self-monitoring is higher among patients using a smartphone app than among those using a paper diary (13).

Outcomes and Follow-up

The primary outcome was change in weight at 6 months in the intervention group compared with the usual primary care group. Weight was measured at baseline, 3 months, and 6 months. Secondary outcomes were systolic blood pressure and 3 self-reported behavioral mediators of weight loss: exercise, dieting, and self-efficacy in weight loss. Data on these outcomes were also collected at baseline, 3 months, and 6 months (**Appendix A** in the **Data Supplement**, available at www.annals.org). The behavioral survey items were adapted from the TRIAD (Translating Research Into Action for Diabetes) study (14) and the Diabetes Empowerment Scale (15).

The MFP company also shared user data with the research team to investigate frequency of app logins over time. Each time a participant opened the app counted as a login. We assessed for contamination at the end of the trial by asking control group participants whether they had used MFP in the past 6 months.

At 6 months, participants in the intervention group completed a survey on their experience using MFP (**Appendix B** in the **Data Supplement**). In addition, we interviewed 6 participants who lost more than 4.5 kg to ask whether they thought MFP helped them lose weight and, if so, how.

Statistical Analysis

We determined that a total sample size of 82 patients (41 per group) would allow us 80% power to detect a 2.5-kg difference in weight change at 6 months between the groups, assuming an SD of 4.0 kg. We set a goal of enrolling 180 participants to account for rates of attrition as high as 55%.

We used a linear mixed-effects model (PROC MIXED) to compare changes in weight, systolic blood pressure, and behavioral survey items between groups from baseline to 3 and 6 months while controlling for clinic site. Month, including baseline, was modeled as a categorical term in the mixed-effects model. This model included fixed effects for clinic, intervention, and month and an intervention-by-month interaction term and used an unstructured variance-covariance matrix to model the covariance structure among the repeated measures by participant. All participants were included in this primary analysis on the basis of their randomized intervention assignment, except for 1 patient in the intervention group who became pregnant and no longer met inclusion criteria.

The proportion of participants in each group who lost at least 2.7 kg at 6 months was also calculated. The analysis of this dichotomous outcome had not been prespecified in the protocol but was added to assess subgroups of patients who achieved significant weight loss.

Bivariate correlation and linear regression analyses were run to assess the relationship between background characteristics and extent of app use. We also used linear regression to determine whether baseline self-efficacy was a

significant predictor of weight change while we controlled for the interaction between baseline self-efficacy and group assignment. All analyses were performed by using SAS, version 9.3 (SAS Institute).

We conducted 2 sensitivity analyses to further evaluate our primary outcome results. The first analysis explored the effect of possible informative drop out, based on a selection model using PROC QLIM (16). This model assumed the existence of unobserved factors related to both outcomes and missingness, considered as a “missing not at random” assumption. We included income, education, diet experience, treatment group, and baseline value as covariates in the binary model for missingness. The second sensitivity analysis gauged the effect of excluding 1 outlier participant in the control group who made extensive use of MFP and lost the most weight of any participant.

Role of the Funding Source

Our research was supported by the Robert Wood Johnson Foundation Clinical Scholars Program (grant 69003). The use of REDCap and a portion of the work of Drs. Mangione and Bell are supported by the National Institutes of Health/National Center for Advancing Translational Sciences UCLA Clinical and Translational Science Institute (grant UL1TR000124). Dr. Mangione received support from the UCLA Resource Centers for Minority Aging Research Center for Health Improvement of Minority Elderly under the National Institutes of Health/National Institute on Aging (grant P30-AG021684). Dr. Mangione holds the Barbara A. Levey and Gerald S. Levey Endowed Chair in Medicine, which partially supported her work. None of the funding sources had a role in the design, conduct, or analysis of the study.

RESULTS

Participant Characteristics

The participants were mostly women (73%) and had a mean age of 43.3 years (SD, 14.3 years) and mean BMI of 33.4 kg/m² (SD, 7.09 kg/m²). Among the participants, 33% self-identified as Hispanic or Latino, 48% as white, 19% as black, 8% as Asian, and 2% as Native American or Pacific Islander (participants were allowed to choose >1 option). Additional sample characteristics are shown in **Table 1**. Characteristics by clinic site are reported in **Table 2**.

At 3 months, 26% of intervention group participants and 21% of control group participants were lost to follow-up or had withdrawn from the study (*P* = 0.69). At 6 months, 32% of intervention group participants and 19% of control group participants were lost to follow-up or had withdrawn from the study (*P* = 0.063).

Weight Loss and Systolic Blood Pressure

There was minimal weight change in both groups and no statistically significant difference between groups. At 3 months, participants in the control group gained an average of 0.24 kg, whereas those in the intervention group lost

Table 1. Participant Characteristics

| Characteristic | Control Group (n = 107) | Intervention Group (n = 105) |
|--|-------------------------|------------------------------|
| Women, n (%) | 81 (76) | 73 (70) |
| Self-reported race/ethnicity, n (%)* | | |
| Hispanic | 34 (32) | 34 (33) |
| White | 43 (42) | 55 (53) |
| Black | 20 (20) | 19 (18) |
| Asian | 10 (10) | 7 (7) |
| Native American or Pacific Islander | 1 (0.5) | 3 (1) |
| Education, n (%) | | |
| High school or less | 26 (24) | 15 (14) |
| Some college or college graduate | 59 (55) | 66 (63) |
| >4 y of college | 22 (21) | 24 (23) |
| Annual income, n (%) | | |
| <\$30 000 | 28 (28) | 23 (25) |
| \$30 000–\$49 000 | 22 (22) | 12 (13) |
| \$50 000–\$74 999 | 18 (18) | 20 (22) |
| ≥\$75 000 | 34 (33) | 38 (41) |
| Mean age (SD), y | 43.2 (15) | 43.1 (14) |
| BMI | | |
| Mean BMI (SD), kg/m ² | 33.3 (7) | 33.3 (7) |
| Participants with BMI 25–30 kg/m ² , n (%) | 41 (38) | 40 (38) |
| Participants with BMI >30 kg/m ² , n (%) | 66 (62) | 65 (62) |
| Mean systolic blood pressure (SD), mm Hg | 123 (18.1) | 126 (15.8) |
| Baseline self-reported behaviors | | |
| Healthy diet, d/wk† | 3.18 (2.45) | 2.89 (2.39) |
| Used calorie goal, d/wk† | 1.31 (2.44) | 1.31 (2.28) |
| Physical activity, d/wk† | 3.81 (2.21) | 3.55 (2.22) |
| Exercise sessions, d/wk† | 1.83 (2.04) | 1.92 (2.10) |
| Self-efficacy in achieving weight-loss goal‡ | 7.77 (2.39) | 8.12 (1.98) |
| Self-efficacy in making healthy food/exercise choices‡ | 7.94 (2.62) | 7.84 (2.29) |
| Liked using smartphone‡ | 8.35 (2.30) | 8.00 (2.33) |
| Type of smartphone, n (%)§ | | |
| iPhone | 50 (51) | 46 (45) |
| Android | 43 (43) | 45 (44) |
| BlackBerry | 6 (6) | 12 (12) |

BMI = body mass index.

* Participants could report >1.

† Mean (SD) number of days in the past 7 d in which the behavior was followed or practiced.

‡ Mean (SD) value on a scale of 0 to 10.

§ Manufacturer information is as follows: iPhone, Apple; Android, Google; BlackBerry, Research in Motion.

0.03 kg (between-group difference, −0.27 kg [95% CI, −1.13 to 0.60 kg]; *P* = 0.53). At 6 months, participants in the control group gained an average of 0.27 kg and those in the intervention group lost 0.03 kg (between-group difference, −0.30 kg [CI, −1.50 to 0.95 kg]; *P* = 0.63) (**Table 3**). These CIs exclude our predetermined clinically significant difference in weight change between groups of 2.5 kg. Difference in systolic blood pressure change between groups was also minimal. The sensitivity analysis based on possible informative dropout provided consistent results (between-group difference at 6 months,

Table 2. Participant Characteristics, by Clinic Site

| Characteristic | Clinic 1 (n = 120) | Clinic 2 (n = 92) |
|--|-----------------------|----------------------|
| Women, n (%) | 80 (67) | 74 (80) |
| Self-reported race/ethnicity, n (%) | | |
| Hispanic | 41 (34) | 27 (29) |
| White | 56 (47) | 42 (46) |
| Black | 23 (20) | 16 (18) |
| Asian | 7 (6) | 10 (11) |
| Native American or Pacific Islander | 3 (0.03) | 1 (0.01) |
| Education, n (%) | | |
| High school or less | 32 (27) | 9 (10) |
| Some college or college graduate | 68 (57) | 57 (62) |
| >4 y of college | 20 (17) | 26 (28) |
| Annual income, n (%) | | |
| <\$50 000 | 56 (48) | 29 (37) |
| ≥\$50 000 | 60 (52) | 50 (63) |
| BMI, n | | |
| 25–30 kg/m ² | 43 | 38 |
| >30 kg/m ² | 77 | 54 |
| Type of smartphone, n (%)* | | |
| iPhone | 51 (43) | 45 (53) |
| Android | 57 (48) | 32 (38) |
| BlackBerry | 10 (9) | 8 (9) |

BMI = body mass index.

* Manufacturer information is as follows: iPhone, Apple; Android, Google; BlackBerry, Research in Motion.

0.04 kg [CI, −1.38 to 1.45 kg]; $P = 0.96$) (Appendix C in the Data Supplement).

Among participants with 6-month measurements, 14 of 87 (16%) in the control group and 13 of 71 in the intervention group (18%) lost 2.7 kg or more.

Self-Reported Behavioral Mediators

At 3 and 6 months, intervention group participants reported using a “personal calorie goal” more often than control group participants (mean between-group difference at 3 months, 1.9 d/wk [CI, 1.0 to 2.8 d/wk]; $P < 0.001$; at 6 months, 2.0 d/wk [CI, 1.1 to 2.9 d/wk]; $P < 0.001$). At 3 months, intervention group participants reported decreased self-efficacy in achieving a weight-loss goal compared with control group participants (between-group difference, −0.85 on a 10-point scale [CI, −1.6 to −0.10]; $P = 0.026$). At 6 months, however, this effect was not significant. We found no statistically significant difference in other self-reported behaviors around diet, exercise, and self-efficacy in weight loss (Table 3). Baseline self-efficacy was not associated with weight loss, either alone or in interaction with group assignment, indicating that participants with greater baseline self-efficacy did not lose more weight and did not differentially lose more with the intervention.

App Use

Over the 6-month study period, the mean total number of logins was 61 and the median total number of logins

was 19. Frequency of logins among most users decreased rapidly after enrollment (Table 4). The median number of logins was 8 (IQR, 2 to 24) in the first month and 0 (IQR, 0 to 2) in the sixth month.

The number of participants who used the app in the first month was 94, compared with 34 in the sixth month. A few participants used the app at least 30 times in month 6 (Figure 2). Among the 105 intervention group participants, 3 never logged in and 8 did not have data available from MFP.

Although clinicians, clinic staff, and control group patients were blinded to the name of the app, 14 of the 107 control group participants (13%) used MFP during the trial. The participant who used the app the most (782 logins) and lost the most weight (13.1 kg) was in the control group. A sensitivity analysis excluding this outlier participant did not change our primary findings (between-group difference at 6 months, −0.45 kg [CI, −1.52 to 0.73 kg]; $P = 0.46$) (Appendix D in the Data Supplement). None of the participants reported using a weight-loss app other than MFP. There was no statistically significant association between baseline characteristics and extent of app use or weight change.

Reviews of MyFitnessPal

Although app use decreased during the study, participants who completed the survey reported high satisfaction at 6 months, with 79% stating they were somewhat or completely satisfied with the app and 92% reporting they would recommend it to a friend. In addition, 80% indicated they plan to continue using MFP.

Using a checklist, we asked participants, “What do you like about MFP?” Of the 83 participants who responded, 100% reported it was easy to use, 88% reported they enjoyed receiving feedback on their progress, 48% reported it was fun to use, 42% enjoyed the reminder feature, 13% liked the social networking feature, and 83% reported “other.” The most common “other” reasons were that MFP increased awareness of food choices or portion size (18%), provided a thorough database of foods (17%), and included a bar code scanner (10%) (Appendix E in the Data Supplement). Some participants commented that they were able to maintain an improved diet but stopped using the app.

Responses from interviewees who had lost more than 4.5 kg included the following: “I realized I was consuming 5000 to 6000 [calories] per day, and afterward I never ate that much again!”; “The app showed me where my problems are—so I reduced portion sizes and cut back on alcohol, carbs, and sweets”; “It really makes you look at what you’re eating. It helped me select healthier foods and stay on track”; “Thanks so very much for introducing me to this excellent weight-loss program. It has been a life-saver.”

Most participants, however, did not use the app regularly; the most common reasons they gave for stopping use were that it was tedious or that they were too stressed or

Table 3. Mean Changes in Weight, Blood Pressure, and Behavioral Mediators of Weight Loss

| Measure | Change From Baseline | | Between-Group Difference* | |
|--|----------------------|--------------------|---------------------------|---------|
| | Control Group | Intervention Group | Value (95% CI) | P Value |
| Weight, kg | | | | |
| Month 3 | 0.24 | -0.27 | -0.27 (-1.13 to 1.3) | 0.60 |
| Month 6 | 0.27 | -0.03 | -0.30 (-1.50 to 0.95) | 0.63 |
| Systolic blood pressure, mm Hg | | | | |
| Month 3 | 4.9 | 0.92 | -4.3 (-9.4 to 0.73) | 0.093 |
| Month 6 | 1.5 | -0.34 | -1.7 (-7.1 to 3.8) | 0.55 |
| Self-reported behaviors | | | | |
| Healthy diet in past 7 d† | | | | |
| Month 3 | 0.34 | 0.3 | 0.03 (-0.74 to 0.80) | 0.94 |
| Month 6 | 0.67 | 0.9 | 0.29 (-0.51 to 1.1) | 0.48 |
| Used calorie goal in past 7 d† | | | | |
| Month 3 | -0.15 | 1.8 | 1.9 (1.0 to 2.8) | <0.001 |
| Month 6 | 0.27 | 2.3 | 2.0 (1.1 to 2.9) | <0.001 |
| Physical activity in past 7 d† | | | | |
| Month 3 | 0.24 | 0.87 | 0.62 (-0.12 to 1.4) | 0.10 |
| Month 6 | 0.66 | 0.87 | 0.20 (-0.49 to 0.90) | 0.56 |
| Exercise sessions in past 7 d† | | | | |
| Month 3 | 0.17 | 0.19 | 0.016 (-0.63 to 0.66) | 0.96 |
| Month 6 | 0.62 | 1.02 | 0.40 (-0.35 to 1.2) | 0.29 |
| Self-efficacy in achieving weight-loss goal‡ | | | | |
| Month 3 | 0.50 | -0.44 | -0.85 (-1.6 to -0.10) | 0.026 |
| Month 6 | 0.49 | -0.03 | -0.44 (-1.1 to 0.21) | 0.19 |
| Self-efficacy in making healthy food/exercise choices‡ | | | | |
| Month 3 | 0.14 | 0.14 | -0.0 (-0.81 to 0.81) | 1.00 |
| Month 6 | 0.44 | 0.41 | -0.03 (-0.74 to 0.69) | 0.94 |

* Intervention group values minus control group values. Predicted between-group differences calculated by using linear mixed-effects model.

† Number of days in the past 7 d in which the behavior was followed or practiced.

‡ Scale of 0 to 10.

busy. Overall, use of the social networking feature was minimal, with 80% of participants reporting having “no friends” in the MFP app.

Not all reviews were positive. Using a checklist, we asked intervention group participants, “If you stopped using MFP, why did you stop using it?” Of the 58 participants who responded, 84% reported it was tedious, 24% reported it was not easy to use, and 88% reported “other.” The most common “other” reasons were being too busy or stressed (28%), losing or replacing a smartphone (16%), having technical problems (7%), and encountering difficulty with logging home-cooked foods (6%) (Appendix F in the Data Supplement).

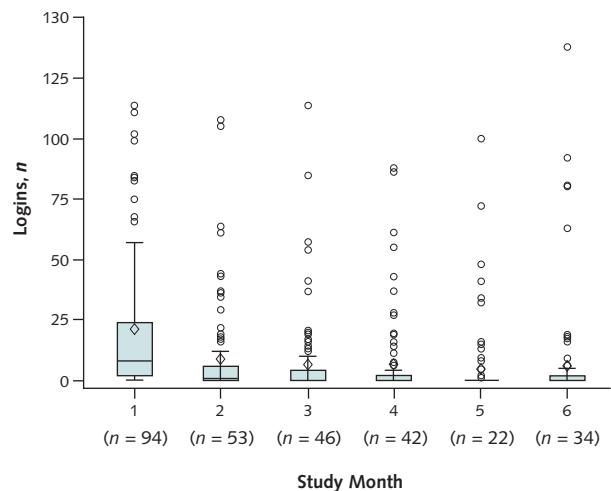
Table 4. Logins Among Intervention Group Participants, by Month

| Characteristic | Month | | | | | |
|-----------------------------------|---------|---------|---------|---------|---------|---------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Participants who logged in, n (%) | 94 (97) | 53 (55) | 46 (47) | 42 (43) | 22 (23) | 34 (35) |
| Mean logins, n | 20.9 | 8.6 | 6.5 | 6.3 | 4.3 | 6.2 |
| Median logins, n | 8 | 1 | 0 | 0 | 0 | 0 |
| Interquartile range | 2-24 | 0-6 | 0-4 | 0-2 | 0-0 | 0-2 |
| Range | 0-114 | 0-108 | 0-114 | 0-88 | 0-100 | 0-138 |

DISCUSSION

The principal finding of our 6-month trial was that delivery of the MFP app to overweight patients in primary care did not result in increased weight loss compared with

Figure 2. Number of logins among MyFitnessPal users, by month.



Boxes represent the median number of logins and interquartile range.

usual primary care. Most participants rarely used the app after the first month of the study, and few individuals continued to log in regularly in the sixth month. Given these results, it may not be worth a clinician's time to prescribe MFP to every overweight patient with a smartphone. If a patient seems particularly motivated to lose weight and track calories, however, this app may serve as a helpful tool. Our analysis did not show any demographic covariates to be important predictors of app use.

One possible explanation for our negative results is that study participants may have wanted to lose weight but were not ready to put in the necessary work to self-monitor their diet. Although all participants responded that they were "interested in losing weight" during the screening process, we did not explicitly measure readiness for change or motivation. The relative lack of change in behavioral mediators may suggest that most participants were not ready to invest the time in self-monitoring calories. Our results are also consistent with prior research showing that frequent recording of food intake is key to treating obesity (17).

An alternate explanation of our results is that MFP and similar weight-loss apps may need to be substantially more engaging or less time-consuming to produce weight reduction in the average overweight patient. Most participants' use of the app plummeted after the first month because they found it tedious or felt it took too much time. We also found that MFP may actually decrease a user's confidence in their ability to achieve a weight-loss goal. This may be because the app makes users set an explicit weight-loss goal and subsequently increases awareness of whether they achieve it.

There are myriad opportunities to improve app content and delivery. On the basis of patient feedback, a faster, streamlined interface for entering foods may be a priority. Alternatively, weight-loss apps could assess a person's readiness for self-monitoring before using the app and could prepare new users for the potential time commitment. Delivering engaging messages to educate users about the importance of self-monitoring and to incentivize patients to use the app may increase adherence (18). Brief daily or weekly feedback and encouragement could also boost use and self-efficacy in dieting (13). "Gamification" of the app, financial incentives, or delivery of the app in a setting of group competition could also be important adjuncts to increase motivation to use the app and lose weight (19). A weight-loss app plus a proven weight-loss counseling program could also be a powerful combination of tools (3). Of note, smartphone apps are constantly being updated, so the features of MFP have changed over time, although the core features in the version we tested have remained constant.

If an enhanced version of MFP or a similar app proves to be effective at reducing weight in the future, it could easily be distributed to patients at minimal cost. MFP is free and could be introduced to patients by a medical assistant in less than 5 minutes. In contrast, the long-term

consequences of obesity, such as diabetes and cardiovascular disease, are immensely expensive for the U.S. health care system.

Strengths of this study include the randomized design; implementation in real-world primary care settings; and use of a commercially available, free smartphone app. We searched PubMed and could not find any other randomized, controlled trials of a weight-loss app delivered in primary care.

The study also had several limitations. Contamination of the control group may have affected our results. Another limitation was the relatively high attrition rate. It is possible that some intervention group participants did not follow up because they did not lose weight or did not find the app helpful. If we assume that participants who did not complete the study lost less weight than those who did, our estimate of treatment effect is on the conservative end. In other words, it is unlikely that the missing data would have changed our primary findings from negative to positive. Patients were followed for only 6 months, but we suspect that a trial longer than 6 months would also be unlikely to change our primary findings.

Finally, we did not have clinicians recommend the app to patients, nor did we ask clinicians to follow up with patients regarding use of the app or the patients' progress with weight loss. A clinician's recommendation could motivate a patient to use the app more frequently.

In summary, we found that introducing a weight-loss app to overweight patients in primary care did not result in increased weight loss. In the hands of a patient who is truly ready to self-monitor calories, however, it may be a useful tool for losing weight. For now, readiness and adherence to self-monitoring must be addressed for such apps as MFP to affect obesity and its costly, long-term consequences in primary care settings.

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References

- Stein CJ, Colditz GA. The epidemic of obesity. *J Clin Endocrinol Metab.* 2004;89:2522-5. [PMID: 15181019]
- Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *JAMA.* 2012;307:491-7. [PMID: 22253363]
- Wadden TA, Volger S, Sarwer DB, Vetter ML, Tsai AG, Berkowitz RI, et al. A two-year randomized trial of obesity treatment in primary care practice. *N Engl J Med.* 2011;365:1969-79. [PMID: 22082239]
- Galuska DA, Will JC, Serdula MK, Ford ES. Are health care professionals advising obese patients to lose weight? *JAMA.* 1999;282:1576-8. [PMID: 10546698]
- Heath C, Grant W, Marcheni P, Kamps C. Do family physicians treat obese patients? *Fam Med.* 1993;25:401-2.
- Smith A. Smartphone ownership: 2013 update. 5 June 2013. Accessed at www.pewinternet.org/2013/06/05/smartphone-ownership-2013 on 14 August 2013.
- Cohn M. Hopkins researchers aim to uncover which mobile health applications work. *The Baltimore Sun.* 14 March 2012. Accessed at http://articles.baltimoresun.com/2012-03-14/health/bs-hs-mobile-health-apps-20120314_1_health-apps-mhealth-mobile-health on 17 January 2013.
- Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform.* 2009;42:377-81. [PMID: 18929686]
- Azar KM, Lesser LI, Laing BY, Stephens J, Aurora MS, Burke LE, et al. Mobile applications for weight management: theory-based content analysis. *Am J Prev Med.* 2013;45:583-9. [PMID: 24139771]
- Bandura A, Simon KM. The role of proximal intentions in self-regulation of refractory behavior. *Cognit Ther Res.* 1977;1:177-93.
- McLean N, Griffin S, Toney K, Hardeman W. Family involvement in weight control, weight maintenance and weight-loss interventions: a systematic review of randomised trials. *Int J Obes Relat Metab Disord.* 2003;27:987-1005. [PMID: 12917703]
- Burke LE, Wang J, Sevick MA. Self-monitoring in weight loss: a systematic review of the literature. *J Am Diet Assoc.* 2011;111:92-102. [PMID: 21185970]
- Carter MC, Burley VJ, Nykjaer C, Cade JE. Adherence to a smartphone application for weight loss compared to website and paper diary: pilot randomized controlled trial. *J Med Internet Res.* 2013;15:e32. [PMID: 23587561]
- TRIAD Study Group. The Translating Research Into Action for Diabetes (TRIAD) study: a multicenter study of diabetes in managed care. *Diabetes Care.* 2002;25:386-9. [PMID: 11815515]
- Anderson RM, Funnell MM, Fitzgerald JT, Marrero DG. The Diabetes Empowerment Scale: a measure of psychosocial self-efficacy. *Diabetes Care.* 2000;23:739-43. [PMID: 10840988]
- Allison PD. *Missing Data: Quantitative Applications in the Social Sciences.* London: Sage; 2002:79-82.
- Wadden TA, Berkowitz RI, Womble LG, Sarwer DB, Phelan S, Cato RK, et al. Randomized trial of lifestyle modification and pharmacotherapy for obesity. *N Engl J Med.* 2005;353:2111-20. [PMID: 16291981]
- Patrick K, Raab F, Adams MA, Dillon L, Zabinski M, Rock CL, et al. A text message-based intervention for weight loss: randomized controlled trial. *J Med Internet Res.* 2009;11:e1. [PMID: 19141433]
- Kullgren JT, Troxel AB, Loewenstein G, Asch DA, Norton LA, Wesby L, et al. Individual- versus group-based financial incentives for weight loss: a randomized, controlled trial. *Ann Intern Med.* 2013;158:505-14. [PMID: 23546562]