**MOBILE APPLICATION USE AND HEALTH BEHAVIORS IN YOUNG ADULT FEMALES**

**Abstract**

**Objective**: To examine the impact of mobile phone application use on dietary intake, physical activity, and change strategies in young adult females.

**Methods**: Participants (n=43) were randomly enrolled into a mobile application group using the MyNetDiary app or a phone-based memo group for six weeks. Physical Activity and Change Strategies were assessed via the Health Behavior Survey. Dietary intake was assessed using the National Health and Nutrition Examination Survey (2009-2010) Dietary Screener. Height, weight, waist circumference, and BMI were assessed. Paired t-testsand ANCOVA were used to analyze the data.

**Results**: There were no significant differences found between groups in dietary intake, physical activity, health behavior or physical activity change strategies, or anthropometric measurements at the conclusion of the six weeks.

**Conclusions and Implications**: Use of a mobile app in normal weight young adults did not change behaviors, dietary intake, physical activity frequency, or anthropometric measures.

**Introduction**

One’s habitual dietary consumption pattern influences the risk of chronic disease development, including diseases such as Type 2 diabetes, hypertension, heart disease, certain cancers, nonalcoholic fatty liver disease, osteoporosis and obesity (Bhupathiraju & Tucker, 2011; Buyken, Mitchell, Ceriello, & Brand-Miller, 2010; Caporaso et al., 2012; Gonzalez & Riboli, 2010; Mozaffarian, Hao, Rimm, Willett, & Hu, 2011; Sacks & Campos, 2010; Tucker, 2009). In addition to diet, physical activity level has been shown to affect the development of chronic diseases (Reiner, Niermann, Jekauc, & Woll, 2013; Roberts & Barnard, 2005).Achieving or maintaining a healthy diet and active lifestyle is thus an important step toward reducing chronic disease risk, which will benefit both the individual and society (through reduced health care costs and increased work productivity) (Heidenreich et al., 2011). One of the first ways many individuals start moving toward a healthier diet and lifestyle is by utilizing self-help programs (Breton, Fuemmeler, & Abroms, 2011). Increasingly, many self-help programs revolve around mobile phone application (app) usage (Lieffers & Hanning, 2012). Though mobile phone apps with a diet or exercise focus have increased in popularity in recent years, the question of whether or not these phone apps significantly increase healthy behaviors or positively impact body weight—particularly when compared to paper records, and specifically in a young adult population--has not been explored extensively, making this an important area to research and address.

Mobile phone apps have the potential to conveniently, privately, and inexpensively provide dietary intake, physical activity, and weight self-monitoring data to individuals. Self-monitoring may be enhanced compared to the use of paper records by features such as dietary goal setting and calorie and nutrition intake feedback that is immediate. This information can then be used by individuals to improve eating and physical activity patterns, as well as to aid weight loss efforts, should the latter be a need/desire. Some mobile apps have been embedded with behavioral strategies to help increase healthy behaviors, (Pagoto, Schneider, Jojic, DeBiasse, & Mann, 2013) which may enhance their effectiveness.

 Limited evidence suggests that mobile phones may be promising for helping people improve their eating and exercise habits and in promoting weight loss (Breton et al., 2011; Turner-McGrievy et al., 2013). While the evidence about the efficacy of mobile apps on smartphones is limited, a systematic review of the literature on Internet-based approaches concluded that Internet-based approaches are efficacious for improving behavioral outcomes--including the area of weight loss—and internet-based approaches do correlate with smartphone apps (Breton et al., 2011). Mobile phones are being used more often and the technical capabilities of individuals are advancing. Many individuals carry their phones with them everywhere, which can allow for real-time tracking of diet and activity.

 The above discussion illustrates that mobile phone apps may have a role in helping to promote diet, activity level, and weight changes, but evidence is still not robust and research in a young adult population is quite limited. Further research on mobile phone apps can help establish their efficacy in health promotion and measure the scope of change that these apps can bring about. The purpose of this research was to examine how using a mobile phone app impacted healthy behaviors including dietary intake and physical activity and subsequent changes in anthropometric measures in young adult females.

**Methods**

**Participants**

Healthy, normal weight (average BMI = 23.2), female college students (18-22 years of age) who owned smartphones were recruited through a campus E-mail announcement. Inclusion criteria for participants (n=43) included not currently using or have not used a diet tracking or physical activity tracking app (or a combination of food and physical activity tracking) on their smartphone for at least one month. The study was approved by the XXXXBLINDEDXXXX Institutional Review Board and all participants provided written informed consent. Baseline characteristics of participants can be seen in Table 1.

**Procedures**

Participants were randomly assigned into the mobile phone App group or Memo group prior to baseline measurements. The App group downloaded a free app, MyNetDiary, and was trained in a short (approximately five-minute) tutorial on how to use the app. This app was chosen as it was shown to include the greatest number of evidence-based behavior strategies relative to other apps (Pagoto et al., 2013).

The Memo group was asked to use the memo (notebook) function on their smartphone which served as an electronic paper notebook. Additionally, the Memo group was asked to not use a diet or physical activity-tracking app for the duration of the study. The Memo group was also provided a brief (approximately five-minute) overview of how to track dietary intake and physical activity. Both groups were given directions to record the time at which they ate, descriptions of the food items consumed, and the amounts of food/beverages consumed. Additionally, both groups were asked to record physical activity, noting the day, time, type of activity, and duration in minutes. Participants were not given any specific dietary or physical activity goals.

**Measures**

Anthropometric data including height, weight, and waist circumference were recorded at baseline and six weeks using a standiometer, scale, and tape measure, respectively. Participants completed a food frequency questionnaire (FFQ), physical activity questionnaires, and health behavior survey at baseline and at the conclusion of the six-week study. An adherence questionnaire, which assessed the frequency of use of the app or memo feature per day, was collected at three weeks and after the conclusion of the study.

The validated National Health and Nutrition Examination Survey (NHANES) 2009-2010 dietary screener (FFQ) was used to assess dietary intake (Thompson et al., 2009; Thompson et al., 2004). Physical Activity (PA), Physical Activity Change Strategies (PACS), and Health Behavior Change Strategies (HECS) were assessed via components of the valid and reliable Health Behavior Survey (Carlson et al., 2012; Norman et al., 2010; Robinson et al., 2008).

**Data Analysis**

Data were expressed as mean + standard deviation for continuous variables or as frequency counts (proportions) for categorical variables. Comparisons between groups were examined using independent samples T-test or a Mann Whitney test for continuous variables and a χ2 test of independence for categorical variables. A paired T-test was also used for assessing changes within the groups. ANCOVA, with the baseline value of the dependent variable serving as the covariate, was used to assess change across six weeks. A two-sided α of 0.05 was applied. Data analysis was performed with SPSS (Statistical Analysis System, IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp).

**Results**

**Demographics**

Forty-three female participants were enrolled in and completed the study. There were no significant differences between the two groups in demographic and anthropometric variables (weight, BMI, and waist circumference) at baseline.

**Outcome Measures**

No significant differences were found for changes in anthropometric measures at baseline or at six weeks in either the App or Memo group. Changes in anthropometric measures at baseline and six weeks are presented in Table 2.

The App group showed a significant decrease in fruit consumption, whereas the Memo group showed a significant decrease in cereal consumption. However, all other dietary intake categories were non-significant within and between groups. There were no significant differences found for frequency of obtaining at least 30 minutes of physical activity per day. There were no significant differences found for any PACS item except the item “using surroundings and how they affect the amount of physical activity that was completed” (p=.02). Overall there was not a significant change in total score for PACS or HECS. Changes within and between groups for dietary intakes, physical activity frequency, PACS, and HECS are presented in Table 3.

Adherence to using the App or Memo was assessed at three weeks and at the conclusion of the study. Changes in adherence within and between groups are found in Table 4. There were no significant differences found between or within groups in adherence over the length of the study. There appeared to be a trend in decreasing adherence with the Memo group for recording food intake, however this was not significant (p=0.09).

**Discussion**

To the authors’ knowledge, this is the first study to look into normal weight individuals using a mobile phone for both an App and Memo style of recording dietary intake, physical activity, and the effects on anthropometrics and health behaviors. The overall results suggest that there was not a difference in food intake and physical activity behavior between the use of a mobile app compared to a phone-based memo for tracking dietary intake and physical activity. No significant differences were found between groups in frequency of engaging in physical behavior or any area of dietary intake measured. These findings could have been due to the short duration of the study. Previous studies conducted research over six months with overweight participants and found mobile phone apps to be useful for improving dietary food patterns, which resulted in the greatest weight loss change (relative to a paper diary or website) (Acharya, Elci, Sereika, Styn, & Burke, 2011; Burke et al., 2011; Carter, Burley, Nykjaer, & Cade, 2013). Because our sample included young, presumably healthy, normal-weight females—who may not have had a significant impetus to change current behaviors--we saw very little behavior change and no change in anthropometric measures. Perhaps targeting overweight or obese individuals who are interested in losing weight would yield different results. Previous studies used an overweight sample of participants to assess differences when using a mobile app versus a paper memo (Acharya et al., 2011; Burke et al., 2011; Carter et al., 2013; Robinson et al., 2008; Turner-McGrievy et al., 2013). Weight loss was improved with the use of a mobile app in overweight participants compared to a paper memo group (Acharya et al., 2011; Burke et al., 2011; Carter et al., 2013) and a positive correlation between the use of a mobile app and weight loss has been shown (Atienza, King, Oliveira, Ahn, & Gardner, 2008; Burke et al., 2011; King et al., 2008).

Strengths to the study include the use of a mobile phone in both groups, thus eliminating the cofounding caused by variations in recording methodology. Additionally, adherence was assessed, which is often omitted in other studies (Atienza et al., 2008; Carter et al., 2013).Finally, there is limited research examining normal weight individuals using a mobile app and the attendant effects on anthropometrics and health behaviors.

**Limitations**

The small sample size and the inability to generalize the findings beyond the relatively homogenous study population, which was predominantly white female, normal weight, young adults, are limitations to this study. Also, although brief training and a link to a tutorial were provided to participants in the app group, participants were not provided with supervised practice on the use of the mobile phone app. A previous study had participants trained in on how to use the app, and participants were given a week to practice (Carter et al., 2013).Giving participants more time to become familiar with the app could have yielded different results. Additionally, giving focused dietary and physical activity targets prior to commencing recording might lead to more health-related changes, thus allowing for clearer discrimination between the study groups.

**Implications for Research and Practice**

Previous research is consistent with the suggestion that mobile phone apps can be useful for improving dietary habits and physical activity behaviors (Lieffers & Hanning, 2012; Pagoto et al., 2013; Turner-McGrievy et al., 2013).Producing new functions in the apps should be looked into in order to capture the effects of what aspects are creating the changes in dietary and physical activity patterns. For example, researchers could have participants upload their weekly reports to a website where they could find additional information pertaining to their health and wellness gains throughout the duration of the study.

With the increase in use of health-related mobile phone apps, continued research on the effects of these apps within the context of increasing dietary and physical activity behaviors should be addressed within a normal weight population. Studies where the goal is to increase fruit, vegetable, and whole grain intake for prevention of chronic diseases could look into how the use of a mobile phone app may help increase such healthy eating behaviors, thus positively impacting participants’ overall health.

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Table 1.

Baseline Characteristics of Participants Enrolled in a Mobile Phone Application Study (n=43)

|  |  |  |
| --- | --- | --- |
| Characteristic | App Group (n=22) | Memo Group (n=21) |
| Age (years), mean (SD)  | 19.3 (1.3) | 19.9 (1.3 |
| Weight (kg), mean (SD)  | 63.5 (9.9) | 65.94 (6.0) |
| Height (cm), mean (SD)  | 166.41(7.2) | 167.50 (6.7) |
| BMI (kg/m2), mean (SD) | 22.9 (2.7) | 23.5 (2.1) |
| Health rating, mean (SD) | 6.6 (1.9) | 6.6 (1.4) |
| Race/ethnicity (white), n (%) | 18, (82) | 18, (86) |
| Exercise (times per week), mean (SD) | 3.4 (1.5) | 3.7 (1.8) |

Table 2.

Changes in Anthropometric Measures between Baseline and 6 Week Measurements (n=43)

|  |  |  |  |
| --- | --- | --- | --- |
| **Anthropometric Measure** | **App Group (n=22) Mean (SD) (95%CI)** | **Memo Group (n=21)****Mean (SD) (95%CI)** | **p-value** |
| **Weight (kg)** |
| Baseline | 63.5 (9.9) (-7.6-2.7) | 65.9 (6.0) (-7.6-2.7) |  |
| 6 Weeks | 63.7 (8.9) (-5.7-4.9) | 65.1 (7.9) (5.7-4.9) | .99 |
| **BMI (kg/m2)** |
| Baseline | 22.9 (2.6) (-2.2-.8) | 23.0 (2.1) (-2.2-.8) |  |
| 6 Weeks | 22.8 (2.3) (-2.5-.5) | 23.8 (2.5) (-2.5-.5) | .32 |
| **Waist Circumference (in)** |
| Baseline | 28.8 (2.1) (-2.2-.8) | 29.5 (2.6) (-2.2-.8) |  |
| 6 Weeks | 28.9 (2.3) (-1.6-1.6) | 28.9 (2.7) (-1.6-1.6) | .41 |

 Statistically significant at p<0.05

Table 3.

Changes in Dietary Intake, Physical Activity, and Change Strategies between Treatment Groups (n=43)

|  |
| --- |
| **Diet (Times/Week)** |
| **Food Items** | **Group** | **Baseline**Mean (SD) | **6 Weeks** Mean (SD) | **p-valueª** | **p-valueᵇ** |
| Fruit | App | 6.54 (1.50) | 6.23 (1.66) | .03\* |  |
|  | Memo | 6.19 (1.63) | 5.95 (1.72) | .14 | .72 |
| Vegetables | App | 5.23 (2.11) | 4.77 (1.85) | .20 |  |
|  | Memo | 5.57 (2.23) | 5.62 (1.88) | .86 | .13 |
| Whole Grains | App | 4.62 (2.22) | 4.68 (2.25) | .73 |  |
|  | Memo | 4.67 (1.85) | 4.90 (1.58) | .50 | .58 |
| Milk | App | 5.55 (2.81) | 5.41 (2.72) | .65 |  |
|  | Memo | 5.10 (2.74) | 4.86 (3.07) | .48 | .67 |
| Soda | App | 1.45(1.37) | 1.32 (1.25) | .42 |  |
|  | Memo | 2.38 (2.52) | 2.15 (1.98) | .79 | .11 |
| Cereal | App | 3.18 (2.44) | 2.77 (1.95) | .25 |  |
|  | Memo | 3.00 (2.14) | 2.29 (1.65) | .04\* | .36 |
| Greens | App | 5.48 (1.97) | 5.36 (1.97) | .73 |  |
|  | Memo | 4.95 (1.77) | 4.76 (2.10) | .52 | .41 |
| **Behaviors and Strategies** |
| HECS | App | 37.36 (9.34) | 37.00 (7.81) | .79 |  |
|  | Memo | 33.67 (11.04) | 34.57 (11.74) | .64 | .93 |
| PACS | App | 37.27 (7.60) | 37.04 (8.58) | .85 |  |
|  | Memo | 37.05 (9.07) | 35.14 (7.19) | .08 | .25 |
| Physical Activity | App | 3.36 (1.53) | 3.45 (2.10) | .77 |  |
| Frequency | Memo | 3.71 (1.79) | 3.70 (1.69) | .83 | .81 |

\*p<.05 ªp-value paired t-test ᵇp-value ANCOVA

Table 4.

Frequency of Recording (Adherence) of Treatment Groups at Three Weeks and Six Weeks.

|  |
| --- |
| **Within Groups Adherence - Times Per Day**  |
| **Dietary Intake Recording**  | **3 weeks Mean (SD)****Mean (SD)** | **6 weeks Mean (SD)****Mean (SD)** | **p-value** |
| App  | 3.21 (1.84) | 2.79 (2.04) | 0.33 |
| Memo  | 3.00 (2.71) | 2.47 (2.11) | 0.09 |
| **Physical Activity Recording**  |  |
| App  | 1.89 (1.63) | 1.47 (1.58) | 0.13 |
| Memo  | 1.86 (1.74) | 1.81(1.89) | 0.88 |
| **Between Groups** |  |  |
| **Dietary Intake Recording**  |  |  |
| **Treatment**  | **3 weeks Mean (SD)** | **6 weeks Mean (SD)** | **p-value** |
| App  | 3.21 (1.84) | 2.79 (1.99) | 0.74 |
| Memo  | 3.00 (2.16) | 2.47 (2.48) |  |
| **Physical Activity Recording**  |  |
| App  | 1.89 (1.63) | 1.47 (1.58) | 0.37 |
| Memo  | 1.86 (1.74) | 1.81 (1.89) |  |

Statistically significant at p<0.05